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The Orbit of the Planet 'Anahita'

By

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The following work is respectfully submitted as a Thesis for the Degree of Doctor of Philosophy.

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Preface.

The minor planet number (270), "Unohita", is the third known planet in order of distance from the sun in the minor planet group.

This planet has been chosen in order to make a practical application of the theory; first, of determining the elements of a celestial body from four observations; secondly, of correcting the elements thus derived by means of additional observations; and finally as an application of the theory of special perturbations.

In making a complete discussion of this subject, since much difficulty is often encountered by students of Astronomy who have not had

practical experience in making numerical calculations, the arrangement of the formulae and the calculation are given quite fully in the following pages, with the hope that the work might prove serviceable to students pursuing for the first time this line of investigation, by making the path more easier to follow.

Determination of the Orbit of 'Amahita'.

The work of determining the elements of an orbit [illegible] consists in the calculation of what may be called an approximate orbit from three or four observed positions of a celestial body. The orbit thus derived will conform more or less closely to the true orbit according as the observed data are more or less accurate. The value of the latter will not only depend on the skill with which the observations have been made, but also on the assumed positions of the comparison stars. Hence it becomes a matter of the greatest importance in selecting the observations to be used and in computing the elements, to see that the best determined places of the stars of comparison, that can be had, are [illegible].

The second part is the problem of [illegible] which must be compared with the calculated places of the celestial body. Thus by means of the discrepancies which are found between the observed and computed places a closer approximation to the true orbit is found.

Finally the third part consists in finding the influences that any planet may have in pro[illegible] the values of the elements with the lapse of time, from the shock of the calculation of the planet's orbit.

Part First.

Determination of the elements of an orbit from four observed places.—— Equations which determine the [illegible] and the elements.

[illegible] inclination of the plane of the orbit to that of the ecliptic small, an orbit determined from three observed positions is uncertain. To obtain an exact [illegible] observed places. Under all circumstances this method, while it involves somewhat more labor, can, nevertheless, be relied upon in its results.

Six elements are to be found from the given data. The heliocentric co-ordinates and [illegible] functions of these unknown quantities.

[illegible] quantities, which enter into the work of this investigation is as follows:——

t the time

x, y, z [illegible] coordinates;

x', y', z' [illegible];

a [illegible]

the eccentricity of the orbit;

i the inclination of the orbit to the plane of the ecliptic;

ϵ mean longitude at epoch, $t = 0$.

π longitude of the perihelion.

Ω longitude of the ascending node

the six elements of the orbit.

(N.B.) the seventh element, m = the mass, may be [illegible]

ω distance of the perihelion from the node, $= \pi - \Omega$;

f the true anomaly

E the [illegible] anomaly.

λ the ~~true~~ anomaly; mean [illegible]

r the radius vector

k a constant quantity, termed the Gaussian constant, and having the values

$$\log k = 8.235581\,4414_{-10}$$

or $= 3.55000065746$, when expressed in seconds of arc;

[illegible]

a celestial body around the sun, are

$$\frac{d^2x}{dt^2} + k^2\frac{x}{r^3} = 0 ,$$

$$\frac{d^2y}{dt^2} + k^2\frac{y}{r^3} = 0 ,$$

$$\frac{d^2z}{dt^2} + k^2\frac{z}{r^3} = 0 ,$$

or, since,

$$\frac{dx}{dt} = x' , \quad \frac{dy}{dt} = y' , \quad \frac{dz}{dt} = z' ,$$

[illegible] constant,

$$\frac{dx'}{dt} + k^2\frac{x}{r^3} = 0 ,$$

$$\frac{dy'}{dt} + k^2\frac{y}{r^3} = 0 ,$$

$$\frac{dz'}{dt} + k^2\frac{z}{r^3} = 0 ;$$

[illegible] integration of the above equations expresses the integrals in the form

$$\left.\begin{matrix} x, y, z, \\ x', y', z', \end{matrix}\right\} = \varphi(a, e, i, \pi, \Omega, \epsilon, t) ;$$

and also will we find

$$\left.\begin{matrix} a, e, i, \\ \pi, \Omega, \epsilon \end{matrix}\right\} = \varphi(x, y, z, x', y', z', t) ;$$

six functions of the seven variables, which may be regarded as constant [illegible]

[illegible]

The observations themselves do not afford the means of determining immediately the rectangular co-ordinates, since they do not furnish directly the geocentric distances.

Let ξ, η, ζ, be the geocentric rectangular co-ordinates of the celestial body, which in terms of the polar co-ordinates are given by the formulae

$$\xi = \rho \cos \lambda \cos \beta$$

$$\eta = \rho \sin \lambda \cos \beta$$

$$\zeta = \rho \sin \beta$$

where λ and β are the longitude and latitude given by observation, and ρ [illegible] the geocentric distance.

By referring to the Nautical Almanac [illegible] the geocentric co-ordinates of the sun X, Y, Z, [illegible] the dates of our observations. We have then to express the heliocentric co-ordinates of the celestial body by the formulae

$$x = \xi - X$$

$$y = \eta - Y$$

$$z = \zeta - Z$$

[illegible]

Since x, y and z are functions of the six elements of the orbit, each one of the observations gives [illegible] these elements three equations of [illegible] geocentric distance. A second observation will introduce only one [illegible] quantity [illegible] and introduces three new quantities, will only add one new unknown quantity. The observations will then give [illegible] containing nine unknown quantities; and, with the exception where the inclination is small, these nine equations would solve the problem.

Let us first establish the conditions to be fulfilled for three given positions of the celestial body in space, found in the same plane passing through the center of the sun; and then it becomes very simple to pass to four places.

Designating respectively by x', y', z', [illegible] the three given positions. The equation of the plane which

passes through the origin of co-ordinates (the center of the sun) and these three positions, gives

$$Ax' + By' + Cz' = 0$$

$$Ax'' + By'' + Cz'' = 0 ;$$

$$Ax''' + By''' + Cz''' = 0 .$$

In this case A, B and C are functions of the longitude of the node and of the inclination of the orbit.

These three quantities can easily be eliminated in the following manner: multiply the first equation by z' and the second by z', then subtracting

$$A(x'z'' - x''z') + B(y'z''' - y''z') = 0 .$$

From the first and the third in the same manner

$$A(x'z''' - x'''z') + B(y'z''' - y'''z') = 0.$$

Multiply now the first of these last equations by $y'z''' - y'''z'$ and the second by $y''z' - z''y'$ and add, then will B be eliminated and we have

$$A\begin{bmatrix} x'y'z'z''' - x''y'z'z'' \\ - x'y'''z'z'' + x''y'''z'z' \\ + x'y''z'z''' - x'y'z''z''' \\ - x'''y''z'z' + x'''y'z'z'' \end{bmatrix} = 0 ;$$

the first and the sixth terms vanish and the others contain Az' as a common factor. As that quantity will generally be different from zero, and as the second member of the formula is nil, in suppressing the factor Az', we obtain for the equation of condition relative to the plane of the orbit,

$$0 = -x'y'z''' - x'y'''z'' + x''y'''z' + x'y''z''' + x'''y'z'' - x'''y''z' ; \qquad (e)$$

This equation can be written under three different forms:

$$0 = x'(y''z''' - y'''z'') - x''(y'z''' - y'''z') + x'''(y'z'' - y''z') ;$$

$$0 = y'(x''z''' - x'''z'') - y''(x'z''' - x'''z') + y'''(x'z'' - x''z') ;$$

$$0 = z'(x''y''' - x'''y'') - z''(x'y''' - x'''y') + z'''(x'y'' - x''y') ;$$

The factors in parenthesis have a geometric significance: for example, in the first of these equations, its factors contain respectively the co-ordinates of the projections upon the plane of yz, of the second and third, first and third, first and second positions of the celestial body. By considering in the same way the second and third equations, we see that the factors in parenthesis are the co-ordinates of the analogous projections upon the plane xz and xy. These factors in question [illegible]

projections and the origin.

Designate by ixy, ixz, iyz, the inclination of the plane of the orbit respectively, to the three coordinate planes xy, xz, yz. In replacing double the area of the triangle comprised between the three radii vectores, introduce the symbols

$$[r'r''] \; ; \quad [r''r'''] \quad \text{and} \quad [r'r''']$$

which represent, respectively, double the triangular areas, between the first and second, second and third, and first and third positions.

We will have the triangle

$$\Delta = \tfrac{1}{2}[r'r'']\cos ixy \, .$$

Transforming in the same way all the factors which enter into the last equations, we find the relations.

(vide next page.)

$$[r''r'''] \cos iyz = (y''z''' - y'''z')$$

$$[r'r'''] \cos iyz = (y'z''' - y'''z')$$

$$[r'r''] \cos iyz = (y'z'' - y''z')$$

$$[r''r'''] \cos ixz = (x''z''' - x'''z')$$

$$[r'r'''] \cos ixz = (x'z''' - x'''z')$$

$$[r'r''] \cos ixz = (x'z'' - x''z')$$

$$[r''r'''] \cos ixy = (x''y''' - x'''y'')$$

$$[r'r'''] \cos ixy = (x'y''' - x'''y')$$

$$[r'r''] \cos ixy = (x'y'' - x''y')$$

Introducing these values into the preceding equations and writing

$$\frac{[r'r'']}{[r'r''']} = n'' \; ; \quad \frac{[r''r''']}{[r'r''']} = n \; ;$$

we find

$$x'' = nx' + n''x''$$

$$y'' = ny' + n''y'''$$

$$z'' = nz' + n''z'$$

[illegible]

[illegible] be satisfied by the heliocentric co-ordinates of the three given positions in order that they may be situated in the same plane passing through the sun.

If the heliocentric arcs are not too great, we can replace the relations of the triangular areas by a convergent series. The first terms of these series will depend upon the known intervals of time and the radius vector which are simple functions of the heliocentric co-ordinates. These relations can be approximately calculated without much difficulty.

By aid of the relations (4) we will replace now in (5) the heliocentric co-ordinates of the celestial body, by their values in terms of the geocentric co-ordinates of the sun. The introduction of polar co-ordinates into these formulae leads to the question as to what fundamental plane it is most convenient to refer these co-ordinates. The choice of the fundamental plane is generally arbitrary.

The co-ordinate z referred to the ecliptic [illegible] follows that the system of latitude and longitude is especially adopted.

[illegible]

[illegible] The [illegible] of the [illegible] pages 15-20 were transferred to

and bound with pages 76-[illegible]

$$\frac{n}{n'} = \frac{t'}{t'''}\left[1 - Y'x + \quad\right]$$

$$\frac{n}{n''} = \frac{t'}{t'''}\left[1 - Y'x + \quad\right]$$

$$\frac{n_0}{n_0'} = \frac{t'}{t'''}\left[1 - Y_0''x + \quad\right] \qquad (3)$$

$$\frac{n}{n_0''} = \frac{t''}{t'''}\left[1 - Y_0'x + \cdots\cdots\right]$$

The method for determining the expression for the sector of the triangle permits us to express the different quantities Y as functions of the corresponding relations. Conforming to that which is done for the intervals of time, designate by η, the ratio of the sector to [illegible] and for the different [illegible] indicate the η_0 by accents, and we have identical for four [illegible].

$$\frac{n}{n''} = \frac{t'}{t'''}\cdot\frac{\eta'''}{\eta'} = \frac{t'}{t'''}\left[1 - \frac{(\eta'-1) - (\eta'''-1)}{\eta'}\right]$$

$$\frac{n}{n''} = \frac{t''}{t'''}\cdot\frac{\eta'''}{\eta''} = \left[1 - \frac{(\eta''-1) - (\eta'''-1)}{\eta''}\right]$$

$$\frac{n_0}{n_0''} = \frac{t_0'}{t_0'''}\cdot\frac{\eta_0'''}{\eta_0'} = \left[\frac{(\eta-1) - (\eta_0'''-1)}{\eta_0'}\right]$$

$$\frac{n}{n_0''} = \frac{t''}{t_0'''}\cdot\frac{\eta_0'''}{\eta''} = \left[1 - \frac{(\eta-1) - (\eta'''-1)}{\eta''}\right]$$

Comparing this expression with the form (β) we can finally write the approximate formulae for arriving at an [illegible]

$$Y'' = \frac{(\eta'-1)-(\eta'''-1)}{\eta' x}$$

$$Y = \frac{(\eta-1)-(\eta''-1)}{\eta x}$$

$$(\delta)$$

$$Y_0' = \frac{(\eta'-1)-(\eta_0'''-1)}{\eta_0' x}$$

$$Y_0' = \frac{(\eta'-1)-(\eta_0''-1)}{\eta'' x}$$

The excess of η over unity can be [illegible] through successive approximations. (Vide Tables for solving the equation

$$\eta - 1 = \frac{\pi}{\eta^2}\left(\eta + \frac{1}{\eta}\right).$$

[illegible] (δ) [illegible] modification, we will now reduce equations (μ) to the

form for computing the value of ε''' as follows:—

$$\varepsilon''' = \frac{1}{\ }\cdot\frac{\ }{\ }\cdot\frac{\ }{\ }+\frac{\ }{\ }+\frac{\ }{\ }\cdot\frac{\ }{E'}\cdot\ +\alpha\left(\frac{\ }{\ }\cdot\frac{A'}{E'}\cdot Y'-\frac{\ }{\ }\cdot\frac{\ }{E'}\cdot Y'\right)$$

$$\varepsilon_0 = \frac{\ }{\ }\cdot\frac{\ }{\ }-\frac{\ }{\ }\cdot\frac{\ }{E_0''}+\frac{\ }{E_0''}+\frac{t_0'}{t_0'}\cdot\frac{\ }{E_0''}\cdot\varepsilon'+\alpha\left(\frac{\ }{\ }\cdot\frac{A'}{E'}\cdot Y_0-\frac{\ }{\ }\cdot\frac{\ }{\ }\cdot Y_0'\right)$$

[illegible]

$$a = \frac{1}{1'}\cdot\frac{A'}{E'''}-\frac{1''}{1'}\cdot\frac{B'}{E'''}+\frac{C'}{E'''}$$

$$a_0 = \frac{1'}{1''}\cdot\frac{A'}{E_0''}-\frac{1''}{1''}\cdot\frac{B'}{E_0''}+\frac{C_0'}{E_0''}$$

$$b = \frac{1'}{1'''}\cdot\frac{A'}{E'}\cdot Y'-\frac{1''}{1'''}\cdot\frac{B'}{E'''}\cdot Y''$$

$$b_0 = \frac{1'_0}{1''_0}\cdot\frac{A'_0}{E''_0}\cdot Y'-\frac{1''}{1''_0}\cdot\frac{B'_0}{E'''_0}\cdot Y''_0$$

$$d = \frac{1'}{1''}\cdot\frac{E'}{E'''}$$

$$d_0 = \frac{1}{1'_0}\cdot\frac{E'_0}{E'_0}$$

[illegible] substituting [illegible] equations (u) [illegible]

[illegible] we have [illegible]

$$\xi' = a + bx + d\xi'$$

$$\xi' = a_0 + b_0 x + d_0 \xi'$$

Subtract and solve for ξ', then add and we will have

$$\xi' = \frac{(a - a_0) + (b - b_0)x}{(d' - d)}$$

$$\xi' = \frac{1}{2}\left[(a + a_0) + (b + b_0) + (d + d_0)\xi'\right].$$

Here a and a_0, d and d_0 are constants so long as the intervals [illegible] are not changed. But b and b_0 are variables, while Y depends [illegible] terms of the third and higher orders. In practice the Y's can be replaced by approximate values, which are functions of the intervals of time and of the radii vectors r' and r''. With these transformations which we have introduced the computer or most [illegible] for the calculation of a planetary orbit. In making

the first approximation we begin the calculation by using the [illegible]

$$\frac{n}{n'} = \frac{1'}{1''}\left[1 - Y'x + \cdots\right]$$

$$\frac{1}{n'} = \frac{1'}{1''}\left[1 - Y'x + \cdots\right]$$

$$\frac{n}{n'} = \frac{1'}{1''_0}\left[1 - Y''_0 x + \cdots\right]$$

$$\frac{1}{n''_0} = \frac{1''}{1'''_0}\left[1 - Y'_0 x + \cdots\right]$$

Here we substitute for the trial values of the Y'_0 as follows:

$$Y'' = \frac{1}{3}(1' - 1'')$$

$$Y'' = \frac{1}{3}(1'' - 1''')$$

$$Y'_0 = \frac{1}{3}(1' - 1'''_0)$$

$$Y'_0 = \frac{1}{3}(1'' - 1'_0)$$

and with the values of the Y's [illegible]

[illegible]

$$Y'' = \frac{(\eta'-1) - (\eta'''-1)}{\eta' x}$$

$$Y' = \frac{(\eta'-1) - (\eta'''-1)}{\eta'' x}$$

$$Y_0'' = \frac{(\eta_0'-1) - (\eta_0'''-1)}{\eta_0' x}$$

$$Y_0' = \frac{(\eta''-1) - (\eta_0'''-1)}{\eta'' x}$$

with which deduced values of the Y's a second hypothesis [illegible] be formed. Proceeding in this way the equations can be written in the convenient form for computation as follows:—

$$a = (1) + (2) + c$$

$$b = (1)Y' + (2)Y''$$

$$a_0 = (1)_0 + (2)_0 + c_0$$

$$b_0 = (1)_0 Y' + (2)_0 Y_0''$$

$$I = a_0 - a$$

$$II = (3) - (3)_0$$

$$\text{III} = b - b_c$$

$$\text{IV} = (3)_c Y_c' - (3) Y'$$

$$\text{V} = \frac{1}{2}(u_0 + u)$$

$$\text{VI} = \frac{1}{2}\left((3) + (3)_0\right)$$

$$\text{VII} = \frac{1}{2}\left(b + b_0\right)$$

$$\text{VIII} = \frac{1}{2}\left[(3) Y_c' + (3) Y'\right].$$

[illegible]

$$(1) = \frac{t'}{t'''} \cdot \frac{A'}{E'''}$$

$$(1)_c = \frac{t_c'}{t_c'''} \cdot \frac{A_c'}{E_c'''}$$

$$(2) = -\frac{t''}{t'''} \cdot \frac{B'}{E'''}$$

$$(2)_c = -\frac{t_c''}{t_c'''} \cdot \frac{B_c'}{E_c'''}$$

$$(3) = \frac{t'}{t'''} \cdot \frac{E'}{E'''}$$

$$(3)_c = \frac{t_c'}{t_c'''} \cdot \frac{E_c'}{E_c'''}.$$

$$C' = \frac{C'}{E'''}$$

$$C_c = \frac{C_c'}{E_c'''}.$$

We now have certain equations between the geocentric distances ξ' and ξ''' and the quantity x, which are simple functions of r'' and r'''. By combining these equations with the relations, which the extreme observations furnish between the same quantities, we will obtain ξ' and ξ''' by approximations.

In the determination of the orbit in the present case, in the first trial we have put $x = 0.025$ as an approximate value to start with. [illegible] calculate the value corresponding to ξ' and ξ''' by aid of the [illegible]

$$\xi' = \frac{\mathrm{I} + \mathrm{III}\,x}{\mathrm{II} + \mathrm{IV}\,x}$$

$$\xi''' = \mathrm{V} - \mathrm{VII}\,x + [\mathrm{VI} - \mathrm{VIII}]\,\xi'$$

where we use the above given relations. Employing now the following auxiliary relations:-

(Vide next page)

$$\cos k' = \cos \beta' \cos (\lambda' - L')$$

$$\sin k' \cos P' = \cos \beta' \sin (\lambda' - L')$$

$$\sin k' \sin P' = \sin \beta'$$

$$\cos k''' = \cos \beta''' \cos (\lambda''' - L''')$$

$$\sin k''' \cos P''' = \cos \beta''' \sin (\lambda''' - L''')$$

$$\sin k''' \sin P''' = \sin \beta'''$$

$$f_1 = R' \cos k'$$

$$B' = R' \sin k'$$

$$f_{III} = R''' \cos k'''$$

$$B'' = R''' \sin k''' \quad .$$

With these relations we can now deduce from ϱ' and ϱ''' the radii vectores r' and r''' by the formulae : –

$$\frac{\varrho' - f_1}{B'} = \tan \theta'$$

$$r' = (\varrho' - f_1) \operatorname{cosec} \theta'$$

$$\frac{\varrho''' - f_{III}}{B'''} = \tan \theta'''$$

$$r''' = (\varrho''' - f_{III}) \operatorname{cosec} \theta'''$$

and also

$$x = \frac{4}{[illegible]} \quad .$$

The radii vectors lead themselves to the value of x. The final value of x will now coincide with the initial value, except by chance our first hypothesis should be exact. This can scarcely be expected and several approximations have to be made before a final value is found which shall agree with the initial value.

Having obtained the values of r' and r''', ξ' and ξ''' which satisfy the equations, if the approximations obtained can be regarded sufficient for the adopted hypothesis, it only remains to proceed according to the general method of deducing the elements from ξ' and ξ'''. If the approximations do not prove sufficient then additional hypotheses must be made.

On account of the relative smallness of the inclination of the orbit, the geocentric motion in longitude does not affect the geocentric motion in latitude, thus with regard to the two great circles, which replace the mean observations, without introducing sensible error, we can put:

$$I = 90^\circ \quad . \quad I_0 = 90^\circ$$

$$\Pi = \lambda'' \qquad \Pi_0 = \lambda''_0$$

[illegible]

Having now briefly treated the theory of the calculations we will in the following section collect the [illegible]

Collection of Formulae

Collecting together the necessary formulae used in making the calculations of the elements in the order in which they will be used, and in the form most convenient for computing, we will have in the first place the four normal places, which will give the geocentric places of the planet referred to the mean equinox and equator of the beginning of the year which we have chosen as our epoch and for a given meridian which we will choose as that of Greenwich.

	Date	Right Ascension	Declination
1	T'	α'	δ'
2	T''	α''	δ''
3	T_0''	α_0''	δ_0''
4	T'''	α'''	δ'''

The four observed positions of the

stand are to be transformed into longitude and latitude by the

[illegible]

$$\sin \beta = \cos \varepsilon \sin \delta - \cos \delta \sin \varepsilon \sin \alpha ;$$

$$\cos \beta \sin \lambda = \sin \varepsilon \sin \delta + \cos \delta \cos \varepsilon \sin \alpha ;$$

$$\cos \beta \cos \lambda = \sin \delta \cos \alpha ;$$

$$k \sin u = \sin \delta$$

$$k \cos u = \cos \delta \sin \alpha ,$$

$$\sin \beta = k \sin (u - \varepsilon)$$

$$\sin \beta \sin \lambda = k \cos (u - \varepsilon) ,$$

$$\cos \beta \cos \lambda = \cos \delta \cos \alpha$$

Numbers follow the data :

	[illegible]	Longitude	Latitude	[illegible]	[illegible]
1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Z.

$$E' = \sin(\lambda'' - \lambda') \cos \beta'$$

$$E'' = \sin(\lambda''' - \lambda'') \cos \beta'''$$

$$E'_0 = \sin(\lambda''_0 - \lambda') \cos \beta'$$

$$E_0 = \sin(\lambda''' - \lambda''_0) \cos \beta'''$$

$$A = R' \sin(L' - \lambda'') : E''$$

$$B = R'' \sin(L'' - \lambda'') : E'''$$

$$C = R''' \sin(L''' - \lambda'') : E'''$$

$$D = E' : E'''$$

$$A_0 = R' \sin(L' - \lambda''_0) : E'''_0$$

$$B_0 = R''_0 \sin(L''_0 - \lambda''_0) : E'''_0$$

$$C_0 = R''' \sin(L''' - \lambda''_0) : E'''_0$$

$$D_0 = E'_0 : E_0$$

$$\cos k' = \cos \beta' \cos(\lambda' - L')$$

$$\sin k' \cos P' = \cos \beta' \sin(\lambda' - L')$$

$$\sin k' \sin P' = \sin \beta'$$

$$\cos \alpha''' = \cos \beta''' \cos (\lambda''' - L''')$$

$$\sin \alpha''' \cos \Gamma''' = \cos \beta''' \sin (\lambda''' - L''')$$

$$\sin \alpha''' \sin \Gamma''' = \sin \beta'''$$

$$J' = R' \cos \alpha'$$

$$B' = R' \sin \alpha'$$

$$R'_s = R' \sin (\lambda' - L')$$

$$R'_c = - R' \cos (\lambda' - L')$$

$$J''' = R''' \cos \alpha'''$$

$$B''' = R''' \sin \alpha'''$$

$$R'''_s = R''' \sin (\lambda''' - L''')$$

$$R'''_c = - R''' \cos (\lambda''' - L''')$$

II.

$$t' = k\,(T''' - T'')$$

$$t'' = k\,(T'' - T')$$

$$t''' = k\,(T''' - T')$$

$$\log k = 5.2355514$$

$$t'_0 = k\,(T''' - T''_0)$$

$$t'''_0 = k\,(T''_0 - T')$$

$$(1) = \frac{t'}{t'''} \cdot A$$

$$(2) = -\frac{t''}{t'''} \cdot B$$

$$(3) = \frac{t'}{t'''} \cdot D$$

$$(1)_0 = \frac{t'_0}{t'''_0} \cdot A_0$$

$$(2)_0 = -\frac{t''_0}{t'''_0} \cdot B_0$$

$$(3)_0 = \frac{t'_0}{t'''_0} \cdot D_0$$

$$a = (1) + (2) + C$$

$$I = a_0 - a$$

$$V = \frac{1}{2}\left(a_0 + a\right)$$

$$a_0 = (1)_0 + (2)_0 + C_0$$

$$II = (3) - (3)_0$$

$$III = \frac{1}{2}\left[(3) + (3)_0\right]$$

III

$$k = (1)Y'' + (2)Y'$$

$$\underline{III} = k - k_0$$

$$\underline{VII} = \frac{1}{2}\left(k + k_0\right)$$

$$k_0 = (1)_0 Y_0'' + (2)_0 Y_0'$$

$$\underline{IV} = (3)_0 Y'' + (3) Y''$$

$$\underline{VII} = \frac{1}{2}\left[(3)_0 Y_0'' + (3) Y''\right]$$

$$Y'' = \frac{1}{3}\left(r' - r''\right)$$

$$Y' = \frac{1}{3}\left(r'' - r'''\right)$$

$$Y_0'' = \frac{1}{3}\left(r_0 - r_0''\right)$$

$$Y_0' = \frac{1}{3}\left(r_0'' - r_0'''\right)$$

II.

$$\xi' = \frac{I + III\,x}{II + IV\,x}$$

$$\xi'' = I - IV\,x\,[II - III\,x]\,\xi'$$

$$\tan\theta = \frac{\xi' - \eta}{B'}$$

$$\tan\theta''' = \frac{\xi' - \eta''}{B'''}$$

$$r = \frac{4}{(r' + r)^2}$$

$$r' = (\xi' - \eta_{m}) \operatorname{cosec}\theta'$$

$$r''' = (\xi''' - \eta_{m}) \operatorname{cosec}\theta'''.$$

I.

$$r' \cos(l' - \lambda') \cos b' = \xi' \cos \beta' + R'_c$$

$$r' \sin(l' - \lambda') \cos b' = R'_s$$

$$r''' \cos(l''' - \lambda''') \cos b''' = \xi'' \cos \beta''' + R'''_c$$

$$r''' \sin(l''' - \lambda') \cos b''' = R'''_s$$

$$r' \sin b' = \xi' \sin \beta'$$

$$r''' \sin b''' = \xi'' \sin \beta'''$$

$$\sin^2 \tfrac{1}{2} f = \sin^2 \tfrac{1}{2}(l''' - l') \cos b' \cos b''' + \sin^2 \tfrac{1}{2}(b''' - b')$$

$$\frac{n}{r'''} = \frac{1'}{1''}\left(1 - xY''\right)$$

$$\frac{1}{n''} = \frac{1''}{1'''}\left(1 - xY'\right)$$

$$\frac{n_0}{n_0'} = \frac{1_0'}{1_0''}\left(1 - xY_0\right)$$

$$\frac{1}{n_0''} = \frac{1''}{1_0'''}\left(1 - xY_0'\right)$$

$$r'' \sin 2f''' = r''' n'' \sin 2f''$$

$$r'' \cos 2f''' = r'n + r''' n'' \cos 2f''$$

$$r_0'' \sin 2f_0''' = r''' n_0'' \sin 2f''$$

$$r_0'' \cos 2f_0''' = r'n_0 + r''' n_0'' \cos 2f''$$

And for a check use the formulae :

$$r'' \sin 2f' = r'n \sin 2f''$$

$$r'' \cos 2f' = r''' n'' + r'n \cos 2f''$$

$$r_0'' \sin 2f_0' = r'n_0 \sin 2f''$$

$$r_0'' \cos 2f_0' = r''' n_0'' + r'n_0 \cos 2f''.$$

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

$$m = \frac{[illegible]}{[illegible]}$$

$$n = \frac{m}{\frac{5}{6} + l + \xi}$$

$$l = \frac{\sin^2 \frac{1}{2} f + \tan^2 2\omega}{[illegible]}$$

$$\tan(45^\circ + \omega) = \sqrt[4]{\frac{n}{r}}$$

$$(\eta - 1) = \frac{4}{\eta^2}\left(\eta + \frac{1}{q}\right)$$

The table gives with the argument n the value $\log \eta$

the table gives with the argument $\frac{m}{\eta^2} - l = x$. the value ξ

As a first value of x take $x = \sin^2 \frac{1}{2} f$

VIII

$$\Upsilon'' \quad \frac{(\eta - 1) - (\eta''' - 1)}{\eta' x}$$

$$\Upsilon' = \frac{(\eta'' - 1) - (\eta''' - 1)}{\eta'' x}$$

$$\Upsilon''_0 = \frac{(\eta'_0 - 1) - (\eta''' - 1)}{\eta'_0 x}$$

$$\Upsilon'_0 = \frac{(\eta'' - 1) - (\eta'''_0 - 1)}{\eta''' x}$$

$$m'' = \frac{[illegible]}{(\cos [illegible])}$$

$$\tan(45^\circ + \omega') = \sqrt[4]{\frac{r''}{r'}}$$

$$f = \frac{\sin^2 \frac{1}{2} f'' + \tan^2 2\omega''}{\cos f''}$$

$$n = \frac{m''}{f' + \frac{\zeta}{\sigma} + \frac{5}{6}}$$

$$\sin \frac{1}{2} g = \frac{n'}{g'} - [illegible]$$

$$\cos\tfrac{1}{2}(f''+g)\tan\tfrac{1}{2}\omega'' = \sin\tfrac{1}{2}(F-G)\cos\tfrac{1}{2}q(\gamma)^2$$

$$\cos\tfrac{1}{2}(f''-g)\tan\tfrac{1}{2}\omega'' = \sin\tfrac{1}{2}(F+G)\sin\tfrac{1}{2}q(\gamma)^2$$

$$\sin\tfrac{1}{2}(f''+g)\sec\tfrac{1}{2}\omega'' = \cos\tfrac{1}{2}(F-G)\cos\tfrac{1}{2}q(\gamma)^2$$

$$\sin\tfrac{1}{2}(f''-g)\sec\tfrac{1}{2}\omega'' = \cos\tfrac{1}{2}(F+G)\sin\tfrac{1}{2}q(\gamma)^2$$

where

$$(\gamma)^2 = \frac{\tfrac{1}{2}m''\cos f''}{\eta''}$$

$$\nu''' = F + f'$$

$$\nu' = F - f'$$

$$E_m = G + g$$

$$E_1 = G - g$$

VI.

$$\rho = \frac{[illegible] \sin 2\delta''}{\nu''}$$

$$\nu'' = \sin \varphi \quad \sin \nu''$$

$$u = \rho \cos \varphi$$

$$\mu = \frac{\nu''}{u''}$$

$$\log k'' = 3.5500066$$

$$M' = E_1 - e'' \sin E_1$$

$$M'' = E_1 - e'' \sin E_1$$

$$\mu = \frac{M'' - M'}{[illegible]}$$

$\bar{\underline{\text{Y}}}$ II

$$\tan b' = \tan i \sin(l' - \Omega)$$

$$\tan u' = \tan(l' - \Omega) \sec i$$

$$\frac{\tan b''' - \tan b' \cos(l''' - l)}{\sin(l''' - l')} = \tan i \cos(l' - \Omega)$$

$$\tan u' = \tan(l''' - \Omega) \sec i$$

[illegible]

$$u''' - u' = -\frac{\xi'}{\eta}$$

$$\tau = u' + \Omega - v'$$

$$\pi = u'' + \Omega - v''$$

Computation of the Orbit.

The following normal places are formed from observations of planet (270) for the purpose of computing the elements of the orbit.

Gr. M. T.			α.			δ			
1887.	October.	12.5	[illegible]	[illegible]	[illegible]	+	11°	59'	10" [illegible]
	November	16.5	0	51	25.11	+	[illegible]	[illegible]	38.0
[illegible]	January	11.5	1	[illegible]	50.16	+	10	30	52.7
	February	[illegible]	2	[illegible]	[illegible]	−	15	[illegible]	[illegible]

The reduction of the right ascension to the arc gives

Gr. M. T.			α.		
[illegible]	October.	[illegible]	[illegible]°	[illegible]'	[illegible]
	November	16.5	12	51	14.6
[illegible]	January	11.5	[illegible]	[illegible]	[illegible]
	February	[illegible]	[illegible]	[illegible]	[illegible]

The computation according to the formulas

Formulas for converting ε and δ into λ and β as follows:

I	II	III	IV	V
sin ε	9.3[illegible]7[illegible]2[illegible]	9.34[illegible]2[illegible]7[illegible]	9.5820586	9.7[illegible]
cos δ	9.[illegible]6[illegible]2[illegible]	9.9952289	[illegible]	[illegible]
cos ε	9.9773825	9.9589769	9.9[illegible]	9.9[illegible]
sin δ = k sin u	9.3173922	9.1655537	[illegible]	9.[illegible]
m cos δ = k cos u	9.9855581	9.3425168	9.5747341	9.[illegible]
tan u	9.[illegible]	9.8260[illegible]	9.6864972	9.[illegible]
u	34° 1′ 16″.4	32° 49′ 1″.2	22° 54′ 45″.1	20° 2′ 5″.5
ε	23 27 7.5	23 27 7.1	23 27 7.2	23 27 7.5
sin u	9.7478001	9.7[illegible]	9.6840[illegible]	9.6164996
u − ε	10° 34′ 8″.9	10° 22′ 54″.1	2° 27′ 37″.9	0° 58′ 27″.0
cos(u − ε)	9.9925686	9.9[illegible]	9.9999994	9.9[illegible]
tg k	9.5695921	9.[illegible]0240	9.62[illegible]7[illegible]4	9.7514103
sin(u − ε)	9.2624512	9.2551912	8.6322772[illegible]	8.2304897
sin β	8.8330434	8.6782152	8.[illegible]	7.9519000
cos β sin λ	9.5621607	9.4158743	9.6203508	[illegible]
cos β cos λ	9.9678092	9.9[illegible]42[illegible]58	9.9583894	9.9168003
tan λ	9.5943525	9.4516685	9.6619614	9.8345472
β	3° [illegible]′ 14″.1	2° 53′ [illegible]	1° 1′ [illegible]	0° 3′ 58″.5
λ	21° 2[illegible]′ 10″.9	15° [illegible]′ 10″.9	24° 24′ 45″.2	24° 20′ 2[illegible]′

The [illegible] in the fourth and fifth columns are here taken as being approximately 3".5 and 4".0, respectively.

[illegible] precession for the co-ordinate λ are to be made as follows:

Nutation	(Δλ)	+ [illegible]	+ [illegible]	+ [illegible]	+ [illegible]
Precession	(Δλ)	+ 11.0	+ 6.1	− 1.4	− [illegible]

Applying these quantities to [illegible] λ as deduced above we obtain the reduced positions of the planet referred to the ecliptic and equinox for the epoch 1888.0. The longitude and radius vector of the sun are referred in like manner to the epoch.

(vide next page)

[illegible]

[illegible]			[illegible]				[illegible]			
1887	October	12.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	December	16.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1888.	January	11.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	February	6.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]			[illegible]				[illegible]	
[illegible]	October	12.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	December	16.5	[illegible]	234	21	41.1	log [illegible]	9.9949130
[illegible]	January	11.5	[illegible]	291	16	46.2	log [illegible]	9.9927828
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9.9940572

The computation according to the formulae given in section I is as follows:

[illegible] I.

$\lambda' - \lambda'$	$-$ [illegible]
$\lambda'' - \lambda'$	$+$ [illegible]
$\sin(\lambda'' - \lambda')$	9.0426089$_n$
$\cos\beta'$	9.9989911
$\sin(\lambda''' - \lambda'')$	9.5174277
$\cos\beta'''$	9.9999800
$\log E'$	9.0416900$_n$
$\log E'''$	9.5174077
$L' - \lambda'$	184° 13′ 27″.9
$L'' - \lambda'$	219 14 10.3
$L''' - \lambda''$	302 34 35.1
$\sin(L' - \lambda')$	8.8672505$_n$
$\log R' : E'''$	0.4814179
$\sin(L'' - \lambda'')$	9.8010724$_n$
$\log R'' : E'''$	0.4775053
$\sin(L''' - \lambda'')$	9.9256556$_n$
$\log R'' : E'''$	0.4766795
$\log A$	9.3486684$_n$
$\log B$	0.2785787$_n$
$\log C$	0.4023351$_n$
$\log D$	9.5242823$_n$
C	$-$ 2.525428

$\lambda_0 - \lambda'$	$+$ [illegible]
$\lambda'' - \lambda_0''$	$+$ [illegible]
$\sin(\lambda_0'' - \lambda')$	8.7477571
$\cos\beta'$	9.9989911
$\sin(\lambda''' - \lambda_0'')$	9.2255636
$\cos\beta'''$	9.9999800
$\log E_0'$	[illegible]
$\log E_0'''$	[illegible]
$L' - \lambda''$	174° 40′ 55″.6
$L'' - \lambda_0''$	266 36 46.1
$L''' - \lambda_0''$	293 2 8.5
$\sin(L' - \lambda_0'')$	[illegible]
$\log R' : E_0''$	[illegible]
$\sin(L'' - \lambda_0'')$	9.9992406$_n$
$\log R'' : E_0'''$	0.7672392
$\sin(L''' - \lambda_0'')$	9.9639109$_n$
$\log R''' : E_0'''$	0.7685436
$\log A_0$	9.7402070
$\log B_0$	0.7664798$_n$
$\log C_0$	[illegible]
$\log D_0$	9.5212046
C_0	$-$ 5.400755

[illegible]

$k'-l'$	[illegible]	$k'''-l'''$	76° 38' 29".4
$\cos(k'-l')$	[illegible]	$\cos(k'''-l''')$	9.3636933
$\cos\beta'$	[illegible]	$\cos\beta'''$	9.9999800
$\sin(k'-l')$	[illegible]	$\sin(l'''-k''')$	9.9880876
$\cos k'$	9.9936965	$\cos k'''$	9.3636733
$\log k'$	9.9958[illegible]	$\log k'''$	[illegible]
$\sin k'\sin p'$	8.8230[illegible]	$\sin k'''\sin p'''$	[illegible]
$\sin k'\cos p'$	[illegible]	$\sin k'''\cos p'''$	9.9880676
$\tan p'$	0.2679[illegible]	$\tan p'''$	7.9944289
$\sin$	[illegible]	$\cos$	9.9999788
$\sin k'$	8.8885212	$\sin k'''$	[illegible]
f'	−0.994311	f'''	+ [illegible]
$\log f'$	[illegible]	$\log f'''$	[illegible]
$\log p'$	[illegible]	$\log p'''$	[illegible]
$\log k'$	[illegible]	$\log k'''$	9.9821745
$\log k'$	9.9935310	$\log k'''$	9.3577805

Section II

[illegible] following [illegible] computation according to the formulae in [illegible]

$T'' - T'$	82.000	$T''' - T''_0$	26.000
$T'' - T'$	[illegible]	$T''_0 - T'$	[illegible]
$T''' - T'$	117.000	$T''' - T'$	[illegible]
$\log (T'' - T'')$	1.9138[illegible]	$\log (T''' - T''_0)$	1.4149722
$\log (T'' - T')$	1.5[illegible]	$\log (T''_0 - T')$	1.9596414
$\log (T''' - T')$	2.0681859	$\log (T''' - T')$	2.0681859
$\log t'$	[illegible]	$\log t'_0$	9.6505547
$\log t''$	[illegible]	$\log t''_0$	0.1946228
$\log t'$	0.3037672		
		$\log t''_0 - t'$	9.4559319
$\log t'' - t'$	0.3697459	$\log t'' - t'_0$	[illegible]
$\log t'' - t'$	0.5241179		
		$\log (1)$	[illegible]
$\log (1)$	9.7[illegible]4143	$\log (2)$	[illegible]
$\log (2)$	0.8026966	$\log (3)$	8.9771365
$\log (3)$	[illegible]		
		(1)	+ 0.157086
(1)	− 0.522895	(2)	+ 7.509726
(2)	+ [illegible]		
		C_0	− 5.400755
C	− [illegible]		
		a_0	+ 2.266058
a	+ [illegible]	(1)	− 0.782480
		(2)	+ 0.094872
I	− 1.034492		
		II	− 0.878352
V	+ [illegible]	VI	− 0.344204

Section III

The computation according to the formulae in section III is as follows: —

First Hypothesis

$\log t'$	0.2987906	$\log t'_0$	[illegible]
$\log t''$	9.5592088	$\log t''_0$	[illegible]
$\log t'^2$	0.6075346	$\log t''^2$	[illegible]
$\log 3Y$	0.2114488	$\log 3Y''_0$	[illegible]
$\log 3Y'$	0.5668288	$\log 3Y'_0$	[illegible]
$\log Y''$	[illegible]	$\log Y''_0$	[illegible]
$\log Y'$	0.0897075	$\log Y'_0$	[illegible]
$\log (1)Y'$	9.4527428	$\log (1)_0Y''_0$	[illegible]
$\log (2)Y'$	[illegible]	$\log (2)_0Y'_0$	[illegible]
$(1)Y''$	−0.28[illegible]	$(1)_0Y''_0$	−0.11[illegible]
$(2)Y'$	+7.80556	$(2)_0Y'_0$	+4.00590
b	+7.52197	b_0	+3[illegible]
$\log (3)Y''$	[illegible]	$\log (3)_0Y''_0$	[illegible]
$(3)Y$	−0.4[illegible]	$(3)_0Y'_0$	−0.0[illegible]
III	+[illegible]62387	II	+0[illegible]
VII	+5.70501	VIII	−0.24807
$\log V$	0.5603730	$\log II$	[illegible]
$\log VII$	0.7565571	$\log VIII$	[illegible]

Section III. (continued).

Second Hypothesis.

[illegible]	[illegible]
[illegible]	0.8847457
[illegible]	−0.2649[illegible]
[illegible]	+[illegible]
[illegible]	+[illegible]404144
[illegible]	[illegible]
[illegible]	−0[illegible]
III	+2[illegible]5651
VII	+5[illegible]
[illegible] III	0.5593860
[illegible] VII	0.7475143

[illegible]	[illegible]105[illegible]061
[illegible]	0.5818195
[illegible]	−0.[illegible]
[illegible]	+3.906[illegible]8[illegible]
[illegible]	[illegible]
[illegible]	8.889203
[illegible]	−0.07[illegible]48[illegible]
II	+0.[illegible]
VIII	−0.[illegible]
[illegible] II	[illegible]
[illegible] VIII	[illegible]

Section III. (continued)

Collection of Constants.

log [illegible]	9.3486684$_n$	log A_0	9.7402070
log B	0.2785787$_n$	log B_0	0.7664798$_n$
log C	0.4023351$_n$	log C_0	0.7324[illegible]
[illegible]	9.5242823$_n$	log D_0	9.5212046
log B'	8.8873468	log B'''	9.9821760
log f	9.9975221$_n$	log f'''	9.3577605
[illegible]	−0.994311	f'''	+0.227909
[illegible]	8.5648873$_n$	log R'''_s	9.9821748
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.1493953	log t'	9.6505547
log t''	9.7796494	log t'''	0.1946225
log t	0.3037673		
log (1)	9.7184143$_n$	log $(1)_c$	9.1961389
log (2)	0.8026966	log $(2)_c$	[illegible]
log (3)	9.8940282$_n$	log $(3)_c$	[illegible]
I	−1.034492	II	[illegible]
V	+2.783304	VI	−0.344304
log III	0.5593860	log IV	9.5045374
[illegible]	0.7475143	log VIII	9.3752208$_n$

Section III (continued)

Third Hypothesis

log (1) Y'	9.4219419 n	log (1) Y_0''	[illegible]
log (2) Y	[illegible]	log (2) Y_0'	0.5911007
(1) Y	−0.264206	(1) Y_0'	−0.125491
(2) Y'	+7.66[illegible]	(2) Y_0	+3.900[illegible]4
b	+7.403982	b_0	+3.77[illegible]
log (3) Y''	9.5975558 n	log (3) Y_0''	8.5595694 n
(3) Y''	−0.[illegible]	(3) Y_0''	−0.077601
III	+3.6[illegible]	II	−0.[illegible]
VII	+5.5[illegible]	VIII	−0.236737
log III	0.5601[illegible]	log IV	9.5027954
log VII	[illegible]	log VIII	[illegible] n

Section III (continued)

Fourth Hypothesis.

$\log(\Omega)Y''$	9.4217143_n	$\log(\Omega)Y_0''$	9.1089389_n
$\log(\Omega)Y'$	0.8846266	$\log(\Omega)Y_0'$	0.5909243
$(\Omega)Y'$	-0.264067	$(\Omega)Y_0'$	$-0.1[illegible]$
$(\Omega)Y''$	$+7.667020$	$(\Omega)Y_0''$	$+3.598746$
k	$+7.402[illegible]$	k_0	$+3.770220$
$\log(\Omega)Y$	$[illegible]_n$	$\log(\Omega)Y''$	8.8899365_n
$(\Omega)Y$	$-0.2[illegible]5[illegible]$	$(\Omega)Y_0''$	-0.077612
III	$+2.6[illegible]$	IV	$+0.318053$
VII	$+5.5[illegible]$	VIII	-0.236640
$\log$ III	$0.[illegible]$	$\log$ IV	9.5024495
$\log$ VII	$0.7[illegible]$	$\log$ VIII	9.3740882_n

Section II

	1°	2°	3°	4°
log x *)	8.39794	8.68935	8.3446685	8.7656000
log III x	8.95[illegible]0	9.24971	9.2049685	9.3259600
log IV x	7.94670	8.23811	8.2933685	8.3143600
log VII x	9.15420$_n$	9.44561$_n$	9.5008685$_n$	9.5218600$_n$
log VIII x	7.79257	8.08393	8.1391885	8.1601800
VII x	+0.09094	+0.17771	+0.201822	+0.211817
IV x	+0.00885	+0.01730	+0.019650	+0.020623
VII x	−0.14263	−0.27900	−0.316861	−0.332552
VIII x	+0.00620	+0.01213	+0.013778	+0.014460
I + III x	−0.943651	−0.856781	−0.832669	−0.822674
II + IV x	−0.869502	−0.861052	−0.858702	−0.857729
log(I+III x)	9.97481$_n$	9.9328698$_n$	9.9204724$_n$	9.9152278$_n$
log(II+IV) x	9.93927$_n$	9.9355294$_n$	9.9338425$_n$	9.9333501$_n$
log ξ'	0.03554	9.9978404	9.9866299	9.9818777
ξ'	+1.08527	+0.995040	+0.969683	+0.959130
(VI − VIII) x	−0.338104	−0.332174	−0.330526	−0.329844
log (VI − VIII) x	9.52965$_n$	9.5213656$_n$	9.5192056$_n$	9.5183086$_n$
log ξ'(VI − VIII) x	9.56450$_n$	9.5192360$_n$	9.5058355$_n$	9.5001863$_n$

(continued on next page).

*) The first approximate value for x is taken as log. 8.39794

Section II (continued)

	1d	2d	3d	4th
$f'(\mathrm{II}-\mathrm{III})x$	−0.36603	−0.330526	−0.320506	−0.316363
f''	+2.273744	+2.173778	+2.145937	+2.134389
$f'-f_1$	+2.079581	+1.989351	+1.963994	+1.953441
$f''-f$	+2.045835	+1.945869	+1.918028	+1.906480
$\log(f'-f_1)$	0.31797	0.2987114	0.2931402	0.2908003
$\log B'$	8.88735	8.8873468	8.8873468	8.8873468
$\log\tan\theta'$	1.43062	1.4113646	1.4057934	1.4034535
$\log\sin\theta'$	9.99970	9.9996736	9.9996651	9.9996616
$\log(f'''-f_{III})$	0.31086	0.2891136	0.2828549	0.2802[illegible]
$\log B'''$	9.98218	9.9821760	9.9821760	9.9821760
$\log\tan\theta'''$	0.32868	0.3069376	0.3006789	0.2980562
$\log\sin\theta'''$	9.95680	9.9527137	9.9514747	9.9509470
$\log r'$	0.31827	0.2990378	0.2934751	0.2911387
$\log r'''$	0.35406	0.3363999	0.3313502	0.3292852
r'	+2.0810	+1.990847	+1.965510	+1.954964
r'''	+2.2597	+2.169701	+2.144767	+2.134446
$r'+r'''$	+4.3407	+4.160578	+4.110278	+4.089410
$\log(r'+r''')$	0.63756	0.6191505	0.6138712	0.6116607
$\log(r'+r''')^2$	1.91268	1.8574515	1.8416133	1.8349821
$\log 4$	0.60206	0.6020600	0.6020600	0.6020600
$x\log\frac{4}{r'+r'''}$	8.68935	8.7446085	8.7604467	8.7670[illegible]

Section II. (continued)

	5th	6th	7th
log x	8.7675800	8.7677700	8.7677900
log III x	9.3279400	9.3281300	9.3281500
log IV x	8.3163400	8.3165300	8.3165500
log VII x	9.5238400 n	9.5240300 n	9.5240500 n
log VIII x	8.1621600	8.16[illegible]500	8.6323700
III x	+0.212784	+0.21[illegible]	+0.212887
IV x	+0.020718	+0.020727	+0.020728
VII x	−0.334072	−0.334218	−0.334234
VIII x	+0.014526	+0.014533	+0.014534
I + III x	−0.821707	−0.821613	−0.821604
II + IV x	−0.857634	−0.857625	−0.857624
log (I + III) x	9.9147170 n	9.9146673 n	9.9146625 n
log (II + IV) x	9.9333020 n	9.9332975 n	9.9332969 n
log ε'	9.9814150	9.9813698	9.9813656
ε'	+0.958105	+0.958100	+0.958100
(VI − VIII) x	−0.329775	−0.329771	−0.329770
log (VI − VIII) x	9.5182217 n	9.5182124 n	9.5182111 n
log ε'(VI − VIII) x	9.4996367 n	9.4995822 n	9.4995769 n

Section II (continued)

	5	6	7
$\varepsilon'(\Pi - \Pi)\chi$	−0.315963	−0.315924	−0.315920
ε'	+2.133269	−2.132162	+2.133130
$\varepsilon' - f_{I}$	+1.952420	+1.952321	+1.952311
$\varepsilon''' - f_{III}$	+1.905360	+1.905255	+1.905241
$\log(\varepsilon' - f_{I})$	0.2905732	0.2905513	0.2905490
$\log B'$	8.8873468	8.8873468	8.8873468
$\log \tan \theta'$	1.4032264	1.4032045	1.4032022
$\log \sin \theta'$	9.9996612	9.9996611	9.9996611
$\log(\varepsilon''' - f_{III})$	0.2799771	0.2799527	0.2799499
$\log B'''$	9.9821760	9.9821760	9.9821760
$\log \tan \theta'''$	0.2978011	0.2977767	0.2977739
$\log \sin \theta'''$	9.9508954	9.9508905	9.9508899
$\log r'$	0.2909120	0.2908902	0.2908879
$\log r'''$	0.3290817	0.3290623	0.3290600
r'	+1.953943	+1.953845	+1.953835
r'''	+2.133446	+2.133350	+2.113340
$r' + r'''$	+4.087390	+4.087195	+4.087175
$\log(r' + r''')$	0.6114462	0.6114254	0.6114233
$\log(r' + r''')^3$	1.8343286	1.8342762	1.8342699
$\log 4$	0.6020600	0.6020600	0.6020600
$x = \log \frac{4}{(r' + r''')^3}$	8.7677214	8.7677838	8.7677901

Section IV. (continued).

Second Hypothesis.

	1st	2nd	3rd
log x	8.7677901	8.7657920	8.7658040
log III x	9.3271701	9.3251790	9.3251900
log IV x	8.2723275	8.2703304	8.2703414
log VII x	9.5153044 n	9.5133073 n	9.5133183 n
log VIII x	8.1430109	8.1410138	8.1410248
VI x	+0.2124[illegible]	+0.211436	−0.2[illegible]
IV x	+0.018721	+0.018635	+0.018636
VII x	−0.327570	−0.326067	−0.326076
VIII x	+0.013900	+0.013836	+0.013836
I + III x	−0.822081	−0.823056	−0.8[illegible]005
II + IV x	−0.859631	−0.859717	−0.85[illegible]
log (I + III) x	9.9149140 n	9.9154294 n	9.9154[illegible] n
log (I + IV) x	9.9343121 n	9.9343555 n	9.9343550 n
log ρ'	9.9806025	9.9810739	9.9810717
ε	+0.950318	+0.957357	+0.957352
(VI − VIII) x	−0.330404	−0.330468	−0.330468
log (VI − VIII) x	9.5190453 n	9.5191205 n	9.5191205
log ρ' (VI − VIII) x	9.4996478 n	9.5002034 n	9.5002032

Section II (continued).

Second Hypothesis.

	1st	2nd	3rd
$\varepsilon(\Pi - \Box)$	[illegible]	[illegible]	[illegible]
ε''	[illegible]	+2.140861	[illegible]
$\varepsilon - f_1$	[illegible]	+1.951668	[illegible]
$\varepsilon'' - f_1$	[illegible]	+1.912952	[illegible]
$\log(\varepsilon - f_1)$	[illegible]	0.2904060	[illegible]
$\log B'$	[illegible]	8.8873468	8.8873468
$\log \tan \theta'$	[illegible]	1.4030592	1.4030580
$\log \sin \theta'$	[illegible]	[illegible]	9.9996609
$\log(\varepsilon' - f'')$	[illegible]	[illegible]	0.2817025
$\log B'''$	[illegible]	[illegible]	[illegible]
$\log \tan \theta'''$	[illegible]	0.2995281	0.2995265
$\log \sin \theta'''$	[illegible]	9.9512438	[illegible]
$\log r'$	[illegible]	[illegible]	[illegible]
$\log r'''$	[illegible]	0.3304603	[illegible]
r'	[illegible]	[illegible]	+1.953187
r''	[illegible]	[illegible]	[illegible]
$r' + r''$	[illegible]	[illegible]	[illegible]
$\log(r' + r''')$	[illegible]	[illegible]	[illegible]
$\log(r' + r''')^3$	1.8353163	[illegible]	[illegible]
$\log 4$	0.6020600	[illegible]	0.6020600
$\log x$	8.7664437	[illegible]	[illegible]

Section I (continued)

Third Hypothesis.

	1st	2d	3d
$\log x$	8.7[illegible]05241	8.7[illegible]05250	8.7[illegible]05200
$\log \overline{\mathrm{III}}\, x$	9.3225[illegible]75	9.3220[illegible]87	9.3220[illegible]528
$\log \overline{\mathrm{IV}}\, x$	8.2080[illegible]25	8.2081[illegible]34	8.2081[illegible]45
$\log \overline{\mathrm{VII}}\, x$	9.5130535	9.5131542	9.5131[illegible]08
$\log \overline{\mathrm{VIII}}\, x$	8.1400[illegible]02$_n$	8.1400[illegible]1$_n$	8.1400082$_n$
$\overline{\mathrm{III}}\, x$	+0.211820	+0.211870	+0.211910
$\overline{\mathrm{IV}}\, x$	+0.018501	+0.018505	+0.018563
$\overline{\mathrm{VII}}\, x$	+0.325[illegible]	+0.325952	+0.325887
$\overline{\mathrm{VIII}}\, x$	−0.013800	−0.013809	−0.013804
$\mathrm{I} + \overline{\mathrm{III}}\, x$	−0.822072	−0.822022	−0.822582
$\mathrm{II} + \overline{\mathrm{IV}}\, x$	−0.859791	−0.859787	−0.859799
$\log (\mathrm{I} + \overline{\mathrm{III}})\, x$	9.9152[illegible]$_n$	9.9152003$_n$	9.915[illegible]$_n$
$\log (\mathrm{II} + \overline{\mathrm{IV}})\, x$	9.9343929$_n$	9.9343909$_n$	9.9343[illegible]$_n$
$\log \epsilon'$	9.9508338	9.9508094	9.9507[illegible]23
ϵ	+0.956828	+0.956774	+0.956714
$(\overline{\mathrm{II}} - \overline{\mathrm{III}})\, x$	−0.330498	−0.330495	−0.330500
$\log (\overline{\mathrm{VI}} - \overline{\mathrm{VIII}})\, x$	9.5191689$_n$	9.5191649$_n$	9.519[illegible]15
$\log \epsilon (\overline{\mathrm{II}} - \overline{\mathrm{III}})\, x$	9.5000[illegible]$_n$	9.4999743$_n$	9.49[illegible]538

Section IV (continued)

Third Hypothesis:

	1st	2d	3d
$\rho'(\rho - \Sigma)x$	[illegible]	[illegible]	[illegible]
ρ	[illegible]	[illegible]	[illegible]
$\rho - f_1$	[illegible]	[illegible]	[illegible]
$\rho - f_{\prime\prime}$	[illegible]	[illegible]	[illegible]
$\log(\rho - f_1)$	[illegible]	[illegible]	[illegible]
$\log B$	[illegible]	[illegible]	[illegible]
$\log \tan \theta$	[illegible]	[illegible]	[illegible]
$\log \sin \theta'$	9.9996607	[illegible]	[illegible]
$\log(\rho''' - f_{\prime\prime\prime})$	0.2817804	0.2817681	0.2817863
$\log B'''$	9.9821760	9.9821760	9.9821760
$\log \tan \theta'''$	0.2996044	0.2995921	0.2996103
$\log \sin \theta'''$	9.9512591	9.9512566	9.9512603
$\log r'$	0.2906275	0.2906155	0.2906022
$\log r'''$	[illegible]		
r	[illegible]	[illegible]	[illegible]
r'	+2.140530	+2.140482	+2.140553
$r' + r'''$	+4.093194	+4.093092	+4.093103
$\log(r' + r''')$	0.6120624	0.6120515	[illegible]
$\log(r' + r''')^3$	1.8361872	1.8361545	1.8361581
$\log 4$	0.6020600	0.6020600	0.6020600
[illegible]	[illegible]	8.7659055	8.7659019

Section V.

The computation according to the formulae in section V is as follows: —

First Hypothesis.

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	9.9813056	$\log \sin^2 \frac{1}{2}(l''-l)$	[illegible]
$\log \rho' \cos \beta'$	9.9803567	$\log \cos b'$	[illegible]
$\log R'_c$	9.9985310	$\log \cos b'''$	[illegible]
[illegible]	0.2020340	$\log$ (prod)	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
$\log R'_s$	[illegible]		
$\log \tan(l'-\lambda')$	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	$\log \sin^2 \frac{1}{2}(l''-l)$	8.0750851
[illegible]	[illegible]	$\log \sin^2 \frac{1}{2}(l''-l)$	6.1501702
[illegible]	[illegible]	$\log \sin^2 \frac{1}{2} f''$	9.0827930
		$\log \sin f$	9.5413965
$\log \sin \beta'$	8.8330449		
$\log r' \sin \beta'$	8.8144105	[illegible]	[illegible]
$\log \sin b'$	8.5235226		
		$\log \cos \beta''$	[illegible]
b'	1° 54′ 47″.0	$\log \rho$	[illegible]
		$\log \rho'' \cos \beta''$	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]
$\log r'$	0.2908874	$\log [\rho'' \cos \beta'' + R''_c]$	[illegible]
[illegible]	8.5648924	$\log R_s$	9.9821748
		[illegible]	[illegible]

Three

[illegible]	26°	44′	[illegible]	$\log \sin \beta'''$	7.9824965
λ'	34	20	38.3	$\log r''' \sin \beta'''$	[illegible]
l	61	4	[illegible]	$\log \sin b'''$	7.9824470
				b	0° 33′ [illegible]

Section V (continued)

Second Approximation

$\log \cos \beta'''$	9.9989911	$\log \cos \beta'''$	9.9999800	$\frac{1}{2}(l''' - l')$	20° 18′ 14″.3
$\log \rho$	9.9810717	$\log \rho'''$	0.3305871	$\log \sin^2 \frac{1}{2}(l''' - l)$	9.0806606
$\log \rho' \cos \beta'''$	9.9800628	$\log \rho''' \cos \beta'''$	0.3305671	$\log \cos b'$	9.9997580
$\log R'_c$	9.9955310	$\log R'''_c$	9.3577805$_n$	$\log \cos b'''$	9.9999799
$\mathcal{G}$	0.2918906	$\mathcal{G}$	0.9238962	$\log$ (prod)	9.0803985
$\log [\rho' \cos \beta' + R'_c]$	0.2904216	$\log [\rho''' \cos \beta''' + R'''_c]$	0.2816767	$\mathcal{G}$	0.0005096
$\log R'_s$	8.5648873$_n$	$\log R'''_s$	9.9821748	$\frac{1}{2}$	
$\log \tan (l - \lambda')$	[illegible]	$\log \tan (l''' - \lambda''')$	[illegible]	$\frac{1}{2}(b''' - b')$	−[illegible]
$l' - \lambda'$	−1° 4′ 40″.1	$l''' - \lambda'''$	26° 35′ 44″.8	$\log \sin \frac{1}{2}(b''' - b')$	8.0749788
λ'	21 27 34.7	l'''	34 20 38.3	$\log \sin^2 \frac{1}{2}(b''' - b')$	6.1499576
l'	20 22 54.6	l'''	60 59 23.1	$\log \sin^2 \frac{1}{2} f''$	9.0827930
				$\log \sin f'$	9.5413965
$\log \sin \beta'$	8.8330449	$\log \sin \beta'''$	7.9824965		
$\log r' \sin b'$	8.8141166	$\log r''' \sin b'''$	8.3130836	f'	20° 18′ 26″.1
$\log \sin b'$	8.5233727	$\log \sin b'''$	7.9826246	$2f''$	40 37 12″.2
b'	1° 54′ 44″.0	b'	3° 33′ 1″.8		
$\log \cos b$	[illegible]		[illegible]		
$\log \sin (l - \lambda)$	8.2743889$_n$	Check	9.6517367		
$\log r$	0.2907439		0.3304590		
$\log R_s$	8.5648908		9.9821756		

Section [illegible] continued.

[illegible]

log cos 3'	9.9989911	log cos 3'''	9.9999800	log sin² ½ (b''' − b')	9.0805946
log ζ'	9.9808094	log ζ'''	0.2206457	log cos b'	9.999[illegible]
log ζ' cos 3'	[illegible]	log ζ''' cos 3'''	0.2206257	log cos b'''	[illegible]
log R'c	9.9985310	log R'''c	9.2577805n	log (prod)	9.080[illegible]
log [ζ' cos 3' + R'c]	[illegible]9029 67	log [ζ''' cos 3''' + R'''c]	0.2817434	y'	0.0005095
log R's	8.5648873n	log R'''s	9.9821745		
log tan (λ' − λ')	8.2745906n	log tan (λ''' − λ''')	9.7004214	½ (b''' − b')	−0° 40' 50.4''
λ' − λ'	−1° 4' 11.2''	λ''' − λ'''	26° 38' 32.1''	log sin ½ (b''' − b')	8.0748016
λ'	21 27 34.7	λ''	34 20 38.3	log sin² ½ (b''' − b')	6.1496032
λ'	20 22 53.5	λ'''	60 59 10.4	log sin² ½ f''	9.0808321
				log sin f''	9.5404164
log sin λ'	8.8230[illegible]	log sin 3'''	7.9824967		
log [illegible] b'	8.8[illegible]542	log [illegible] b'''	8.3[illegible]416	f''	20° [illegible]
log [illegible] b'	8.5[illegible]	log sin λ'''	7.9826301	2f''	40 [illegible]
λ'	1° 5' 4.5''	λ'''	0° 3' 1.7''		
log cos b'	9.9997582		9.9999799		
log sin (λ' − λ')	8.2745137n	[illegible]	9.6516820		
log λ'	0.2906155		0.2305115		
log R's	8.5648874n		9.9821747		

Section V (continued)

Fourth Hypothesis

$\log \cos \beta'$	9.9989911	[illegible]	9.9999800	$\frac{1}{2}(t''' - t')$	20° 18′ 6″.5
$\log \varrho'$	9.9807881	$\log \varrho''$	[illegible]		
$\log(\varrho' \cos \beta')$	[illegible]	$\log \varrho''' \cos \beta'''$	[illegible]	$\log \sin^2 \frac{1}{2}(t''' - t')$	[illegible]
$\log R'_c$	[illegible]	$\log R'_c$	[illegible]	$\log \cos t'$	9.9997552
$\log[\varrho' \cos \beta' + R'_c]$	0.2902862	$\log[\varrho'' \cos \beta''' + R'''_c]$	0.2817649	$\log \cos t'''$	9.9999799
$\log R'_s$	8.5648873$_n$	$\log R'''_s$	9.9821748	$\log$ (prod)	9.0803099
$\log \tan(t' - h')$	8.2746011$_n$	$\log \tan(t''' - h''')$	[illegible]	$\frac{1}{2}$	0.0005077
$t' - h'$	−1° 4′ 41″.3	$t'' - h'''$	26° [illegible]	$\frac{1}{2}(t''' - t')$	0° 40′ 50″.3
h'	21 27 34.7	h'''	[illegible]		
t'	[illegible]	t'''	[illegible]	$\log \sin \frac{1}{2}(t''' - t')$	8.0747839
				$\log \sin^2 \frac{1}{2}(t''' - t')$	6.1497678
$\log \sin \beta'$	[illegible]	$\log \sin \beta'''$	[illegible]	$\log \sin \frac{1}{2} f''$	9.0808176
$\log \varrho' \sin t'$	8.8138330	$\log \varrho' \sin t'$	8.3131614	$\log \sin f''$	9.5404088
$\log \sin t'$	[illegible]	$\log \sin t'$	[illegible]		
t'	[illegible]	t'	[illegible]	f''	20° 18′ 25″.1
[illegible]	[illegible]		[illegible]	$\frac{1}{2} f''$	40 36 56.2
$\log \sin(t' - h')$	8.2745242$_n$	[illegible]	9.6516661	$\frac{1}{2} f''$	10 9 14.05
$\log \varrho'$	0.2906050		[illegible]		
$\log R_s$	[illegible]		9.9821747		

Section II

Computation according to formulae

in section II —

$\log Y''$	[illegible]	$\log Y_0''$	[illegible]
$\log x$	8.7677901	$\log x$	8.7677901
$\log Y'$	0.0897075	$\log Y_0'$	9.7270743
$\log x Y'$	8.5021176	$\log x Y_0''$	8.6429[illegible]
β	1.4838581	β	1.3757489
$\log x Y'$	8.8574976	$\log x Y_0'$	[illegible]
β	1.1100348	β	[illegible]
$\log(1-xY'')$	9.9859757	$\log(1-xY_0'')$	[illegible]
$\log t' \div t''$	0.3697459	$\log t_0' \div t_0''$	[illegible]
$\log(1-xY')$	9.9675324	$\log(1-xY_0')$	9.9862104
$\log t' \div t''$	0.5241179	$\log t_0'' \div t_0'''$	0.1091445
$\log n \div n''$	0.3557216	$\log n_0 \div n_0''$	9.4746090
$\log t \div n''$	0.4916503	$\log t_0 \div n_0''$	0.0953549
$\log n''$	9.8640713	$\log n_0''$	9.3792541
$\log r'$	0.2908877	$\log r'$	0.2908877
$\log \sin 2\zeta''$	9.8144203	$\log \sin 2\zeta''$	9.8144203

For continuation see following page

[illegible] problem. Consequently designate by λ, [illegible] longitude, latitude and geocentric distance of the celestial body, by R the geocentric distance of the [illegible] and let L be the solar longitude, and consider the sun's latitude to be zero. Then will we have the following relations

$$\xi = \rho \cos(\lambda - \Pi) \cos \beta$$

$$\eta = \rho \sin(\lambda - \Pi) \cos \beta \qquad (h)$$

$$\zeta = \rho \sin \beta$$

$$X = R \cos(L - \Pi)$$

$$Y = R \sin(L - \Pi) \qquad (i)$$

$$Z = 0$$

In these formulae it is necessary to count the longitudes from [illegible] whose longitude is Π. Designate by accents the different positions of the celestial body which we are [illegible]. By introducing into equations (g) the relations (h) and (h) we can write the following relations

(vide next page.)

$$
\left.
\begin{aligned}
& n[\rho' \cos \lambda' \cos \beta' - R' \cos (L' - \Pi)] \\
& + n''[\rho'' \cos \lambda'' \cos \beta'' - R'' \cos (L'' - \Pi)] \\
& \qquad = \rho'' \sin (\lambda'' - \Pi) \cos \beta'' - R'' \sin (L'' - \Pi) \\
& n[\rho' \sin (\lambda' - \Pi) \cos \beta' - R' \sin (L' - \Pi)] \\
& + n''[\rho'' \sin (\lambda'' - \Pi) \cos \beta'' - R'' \sin (L'' - \Pi)] \\
& \qquad = \rho'' \sin (\lambda'' - \Pi) \cos \beta'' - R'' \sin (L'' - \Pi) \\
& n \rho' \sin \beta' + n'' \rho'' \sin \beta'' \\
& \qquad = \rho'' \sin \beta''
\end{aligned}
\right] \quad (k)
$$

If in the equations (i) we do not put $Z = 0$, the co-ordinates of the sun will take the form

$$
\begin{aligned}
X &= R \cos B \cos (L - \Pi) \\
Y &= R \cos B \sin (L - \Pi) \qquad (l) \\
Z &= R \sin B .
\end{aligned}
$$

where B represents the sun's latitude.

By putting $\Pi = 0$ we will have in place of equations (k)

$$
\left.
\begin{aligned}
& n[\rho' \cos \lambda' \cos \beta' - R' \cos L' \cos B'] \\
& + n''[\rho'' \cos \lambda'' \cos \beta'' - R'' \cos L'' \cos B''] \\
& \qquad = \rho'' \cos \lambda'' \cos \beta'' - R'' \cos L'' \cos B'' \\
& n[\rho' \sin \lambda' \cos \beta' - R' \sin L' \cos B'] \\
& + n''[\rho'' \sin \lambda'' \cos \beta'' - R'' \sin L'' \cos B''] \\
& \qquad = \rho'' \sin \lambda \cos \beta'' - R'' \sin L'' \cos B'' \\
& n[\rho' \sin \beta' - R' \sin B'] \\
& + n''[\rho'' \sin \beta'' - R'' \sin B''] \\
& \qquad = \rho'' \sin \beta'' - R'' \sin B''
\end{aligned}
\right] \quad (m)
$$

In the first determination of an orbit, the last equations have an advantage over equations (k), which becomes appreciable in special cases. If for example, one or more of the observations used in making the calculations, should have the observed latitude very small or even absolutely zero. The introduction of a "fictitious place" becomes impossible, and rigorously the latitude of the sun cannot be fully equal to zero. In such a case we can make use of equations (m) by introducing in the place of L_1, B_1, and R_1, the longitude, latitude and geocentric distance, L_0, B_0 and R_0, of the sun reduced to another preceding to the first position.

It is to be noted that four observations give eight elements, and since it is necessary to find only six elements we can consider two of the observations as incomplete. For an exact determination in the present case, we will take as incomplete the mean observations, i.e., the second and third, and replace them by two great circles which we will consider to have the property of passing through the two mean observations.

We will designate the dates of the four observations by T', T'', T''_0, and T''', also the corresponding longitudes

by λ', λ'', λ''_0 and λ''' and the latitudes by β', β'', β''_0 and β''' [illegible] by I and by I_0 the inclinations of the two great circles to the ecliptic, by Π and Π_0 the longitudes of their ascending nodes. We will have for the conditions which these four last quantities should satisfy

$$\tan I \sin(\lambda'' - \Pi) = \tan \beta''$$

$$\tan I_0 \sin(\lambda''_0 - \Pi_0) = \tan \beta''_0 \qquad (n)$$

Also designate by the same accents as used in the case of the planet, the solar longitudes, latitudes and distances relative to the four observations, and count the longitude in the first place from Π, and in the second from Π_0. For the solar longitudes L', L'', L''_0, L''', for latitudes B', B'', B''_0, B''', and distances R', R'', R''_0 and R'''; it is permissible in the most precise calculations to replace $\cos B$, the solar latitude affected by parallax, by unity and the sine by the arc itself. By making these changes in equations (m) and then writing three additional equations by substituting in these same equations r'_0 for r'' and Π_0 for Π, we will have six equations of the following form

(vide next page)

$$
\left.
\begin{aligned}
& n\left[\xi' \cos(\lambda' - \Pi) \cos\beta' - R' \cos(L' - \Pi)\right] \\
+\ & n''\left[\xi''' \cos(\lambda''' - \Pi) \cos\beta''' - R''' \cos(L''' - \Pi)\right] \\
& \qquad = \xi'' \cos(\lambda'' - \Pi) \cos\beta'' - R'' \cos(L'' - \Pi) \\[2ex]
& n\left[\xi' \sin(\lambda' - \Pi) \cos\beta' - R' \sin(L' - \Pi)\right] \\
+\ & n''\left[\xi''' \sin(\lambda''' - \Pi) \cos\beta''' - R''' \sin(L''' - \Pi)\right] \\
& \qquad = \xi'' \sin(\lambda'' - \Pi) \cos\beta'' - R'' \sin(L'' - \Pi) \\[2ex]
& n\left[\xi' \sin\beta' - R' B' \text{arc } 1''\right] \\
+\ & n''\left[\xi''' \sin\beta'' - R''' B''' \text{arc } 1''\right] \\
& \qquad = \xi'' \sin\beta'' - R'' B'' \text{arc } 1''.
\end{aligned}
\right\} \quad (p)
$$

$$
\left.
\begin{aligned}
& n_0\left[\xi' \cos(\lambda' - \Pi_0) \cos\beta' - R' \cos(L' - \Pi_0)\right] \\
+\ & n''_0\left[\xi''' \cos(\lambda''' - \Pi_0) \cos\beta''' - R''' \cos(L''' - \Pi_0)\right] \\
& \qquad = \xi'' \cos(\lambda''_0 - \Pi_0) \cos\beta''_0 - R''_0 \cos(L''_0 - \Pi_0) \\[2ex]
& n_0\left[\xi' \sin(\lambda' - \Pi_0) \cos\beta' - R' \sin(L' - \Pi_0)\right] \\
+\ & n''_0\left[\xi''' \sin(\lambda''' - \Pi_0) \cos\beta''' - R''' \sin(L''' - \Pi_0)\right] \\
& \qquad = \xi''_0 \sin(\lambda''_0 - \Pi_0) \cos\beta''_0 - R''_0 \sin(L''_0 - \Pi_0) \\[2ex]
& n_0\left[\xi' \sin\beta' - R' B' \text{arc } 1''\right] \\
+\ & n''_0\left[\xi''' \sin\beta''' - R''' B''' \text{arc } 1''\right] \\
& \qquad = \xi''_0 \sin\beta''_0 - R''_0 B''_0 \text{arc } 1''
\end{aligned}
\right\} \quad (q)
$$

Put now

$$\cos(\lambda'' - \Pi)\cos\beta'' = \cos u$$

$$\sin(\lambda'' - \Pi)\cos\beta'' = \sin u \cos I$$

$$\sin\beta'' = \sin u \sin I$$

(7)

$$\cos(\lambda''_0 - \Pi_0)\cos\beta''_0 = \cos u_0$$

$$\sin(\lambda''_0 - \Pi_0)\cos\beta''_0 = \sin u_0 \cos I_0$$

$$\sin\beta''_0 = \sin u_0 \sin I_0$$

u and u_0 will be in these formulae angles purely arbitrary, I and I_0 ought to be deduced only from Π and Π_0 by the formulae (n). Imagine that we have placed in (p) and (q) the quantities constituting the first members of equations (r) by the values following from these relations. The resulting equations will include the arbitrary angles u and u_0. To eliminate immediately the first of these angles we will add in equations (p) the product of the second by $\sin I$ to the product of the third by $-\cos I$. We can in the same way eliminate the u_0 from the last three equations of (q). We thus obtain between ξ' and ξ''' two relations of the form

$$-\rho' n E + \rho'' n'' E''' = n A' - B' + n'' C'$$

$$-\rho''' n_0 E'_0 + \rho''' n'' E'''_0 = n_0 A'_0 - B'_0 + n''_0 C'_0 \qquad (s)$$

where we have written for brevity

$$A' = R'[\sin(L'-\Pi)\sin I - B'\cos I \operatorname{arc} 1'']$$

$$B' = R''[\sin(L''-\Pi)\sin I - B''\cos I \operatorname{arc} 1'']$$

$$C' = R'''[\sin(L'''-\Pi)\sin I - B'''\cos I \operatorname{arc} 1'']$$

$$A'_0 = R'[\sin(L'-\Pi_0)\sin I_0 - B'\cos I_0 \operatorname{arc} 1'']$$

$$B'_0 = R''[\sin(L''-\Pi_0)\sin I_0 - B''\cos I_0 \operatorname{arc} 1'']$$

$$C'_0 = R'''[\sin(L'''-\Pi_0)\sin I_0 - B'''\cos I_0 \operatorname{arc} 1'']$$

$$E' = \sin\beta'\cos I - \sin(\lambda'-\Pi)\cos\beta'\sin I$$

$$E''' = \sin\beta'''\sin I \sin(\lambda'''-\Pi) - \sin\beta'''\sin I$$

$$E'_0 = \sin\beta'\cos I_0 - \sin(\lambda'-\Pi_0)\cos\beta'\sin I_0$$

$$E'''_0 = \cos\beta'''\cos I_0 \sin(\lambda'''-\Pi_0) - \sin\beta'''\cos I_0$$

Solving equations (s) with respect to ρ' and then with respect to ρ'', we will find the following equations for

[illegible] the [illegible] distance

$$\rho' = \frac{\frac{[\text{[illegible]}]}{[\text{[illegible]}]}\cdot\frac{A}{E} - \frac{[\text{[illegible]}]}{[\text{[illegible]}]}\cdot\frac{B'}{E_0'''} + \frac{C'}{E'} - \frac{[\text{[illegible]}]}{[\text{[illegible]}]}\cdot\frac{A'}{E'''} + \frac{[\text{[illegible]}]}{[\text{[illegible]}]}\cdot\frac{B'}{E'} - \frac{C'}{E'''}}{\frac{[r''r''']}{[r'r'']}\cdot\frac{E'}{E'''} - \frac{[r_0''r''']}{[r'r_0'']}\cdot\frac{E'}{E_0'''}} \tag{1}$$

$$\text{[illegible]} = \frac{\frac{A'}{E} - \frac{[r'r''']}{[r''r''']}\cdot\frac{B'}{E'} + \frac{[r'r''']}{[r''r''']}\cdot\frac{C'}{E'} - \frac{A_0'}{E_0'} + \frac{[r'r''']}{[r_0''r''']}\cdot\frac{B'}{E_0'} - \frac{[r'r_0'']}{[r_0''r''']}\cdot\frac{C_0'}{E_0'}}{\frac{[r'r''']}{[r''r''']}\cdot\frac{E'''}{E'} - \frac{[r'r_0''']}{[r_0''r''']}\cdot\frac{E'''}{E_0'}}$$

These relations [illegible] [illegible] [illegible] [illegible] must be calculated in order to [illegible] a [illegible] approximation. If we imagine E', E''' and E_0', E_0''' developed according to the powers of the intervals of time we can establish for these symbols a series of the form

$$E' = a(t''' - b\,t'''^{3} + \ldots)$$

$$E''' = a(t' + b\,t'^{3} + \ldots)$$

$$E_0' = a_0(t_0''' - b_0\,t_0'''^{3} + \ldots)$$

$$E_0''' = a_0(t_0' + b_0\,t_0'^{3} + \ldots)$$

where

$t' = k(T''' - T'')$	$t_0' = k(T''' - T_0'')$
$t'' = k(T''' - T')$	$t_0''' = k(T_0'' - T')$
$t''' = k(T''' - T')$	$\log k = 8.2355814$

It is to be noted that the the first

[illegible] E', E''' [illegible] of the [illegible] perpendiculars [illegible]

by the extreme observations upon the great circle passing through the second observation, while E'_0 and E'''_0 are the sines of the perpendiculars cut off by the same points upon the great circle passing through the third observation. We then have

$$\frac{E'}{E'''} = \frac{t'''}{t'} \cdot \frac{1 - b t''' + \ldots}{1 + b t' + \ldots}$$

$$\frac{E'_0}{E'''_0} = \frac{t'''_0}{t'_0} \cdot \frac{1 - b_0 t'''_0 + \ldots}{1 + b_0 t'_0 + \ldots}$$

By replacing in the expressions the ratios of the triangular areas by the series, we have

$$\frac{[r\, r''']}{[r''\, r''']} = \frac{t''}{t'}\left[1 - \frac{4}{3} \cdot \frac{t''^2 - t'^2}{[r' + r''']^3} - \frac{4\, t''' t'^2}{t''} \cdot \frac{(r' - r)}{(r' + r''')^4} + \quad \right]$$

$$\frac{[r'\, r''']}{[r'\, r'']} = \frac{t'''}{t'} \cdot \left[1 - \frac{4}{3}\, \frac{t'''^2 - t'^2}{(r' + r'')^3} - 4\, t' t''' \cdot \frac{(r''' - r')}{(r' + r''')^4} + \ldots \right] \qquad (x)$$

$$\frac{[r'\, r]}{[r'\, r'']} = \frac{t''}{t'} \cdot \left[1 - \frac{4}{3} \cdot \frac{t' - t'}{(r' + r'')^2} + \frac{4\, t' t''}{t''} \cdot \frac{(r''' - r')}{(r' + r''')^2} + \ldots \right]$$

$$\frac{[r''\, r''']}{[r'\, r'']} = \frac{t'}{t'''} \cdot \left[1 - \frac{4}{3} \cdot \frac{t'^2 - t'''^2}{(r' + r''')^2} + 4\, t' t''' \cdot \frac{(r''' - r')}{(r' + r''')^4} + \ldots \right]$$

Neglecting the terms multiplied by the squares of the products of t, the denominator of the first relation of equation (1) becomes

$$t_0 = t$$

In general t_0 and t will be of the order zero, but their differences will evidently be of the order of the intervals of time. Then by supposing for an instant that the two mean observations are effected at dates infinitely close we should have for a limit

$$t = t_0 .$$

[illegible] sufficient it will be necessary to take account of the terms of the third order in the equations of the triangular areas.

From the preceding considerations it has now been indicated now we can determine the geocentric distances. For the next step solve each of equations (s) with respect ε' and we find

$$\varepsilon''' = \frac{[r''r''']}{[r'r'']}\frac{A'}{E'''} - \frac{[r'r''']}{[r'r'']}\cdot\frac{B'}{E'''} + \frac{C'}{E'''} + \frac{[r''r''']}{[r'r'']}\cdot\frac{E'}{E'''}\cdot\varepsilon' .$$

(u)

$$\varepsilon''' = \frac{[r''r''']}{[r'r'']}\frac{A'}{E'''} - \frac{[r'r''']}{[r'r'']}\cdot\frac{B'}{E'''} + \frac{C'}{E'''} + \frac{[r''r''']}{[r'r'']}\cdot\frac{E'}{E'''}\cdot\varepsilon'$$

[illegible]

The denominators of the fractions, which multiply the expressions for the triangular areas, do not include the symbols E which are of the first order. In general the relations of ϱ''' to ϱ' can be established more exactly by two orders than the geocentric distances. A form can be given to these equations permitting us to utilize this relation [illegible]

We will put now for approximating:

$$Y' = \tfrac{1}{3}(t' - t'')$$

$$Y'' = \tfrac{1}{3}(t'' - t''')$$

$$Y_0' = \tfrac{1}{3}(t_0' - t_0'')$$

$$Y_0'' = \tfrac{1}{3}(t_0'' - t_0''')$$

$$x = \frac{4}{[illegible]}$$

and then transform the series (2) into the expressions for approximation of the form

(vide next page)

[illegible]

[illegible]

log n''	[illegible]		log n''_0	9.9046451
log r'''	[illegible]		log r'''	[illegible]
log cos 2f''	9.8796665		log cos 2f'''	9.8796665
log r' n	[illegible]		log r' n_0	9.6701[illegible]
log r' n cos 2f''	[illegible]		log r' n cos 2f'''	[illegible]
[illegible]	0.4107419		[illegible]	[illegible]
log r'' n''	[illegible]		log r'' n''_0	[illegible]
log r''' n'' cos 2f''	9.7170765		log r''' r'' cos 2f'''	[illegible]
[illegible]	0.5729644		[illegible]	[illegible]
log r' n	0.1549592		log r' n_0	9.6701[illegible]
log r'' [illegible]	9.6518300		log r'' [illegible]	0.04[illegible]
log r'' cos 2f	0.2900409		log r''_0 cos 2f''_0	0.2470[illegible]
log tan 2f'''	9.3617891		log [illegible]	9.8010[illegible]
[illegible]	[illegible]		[illegible]	[illegible]
log cos 2f'''	9.9888034		log [illegible]	[illegible]
log r''	0.3012375		log r''_0	[illegible]
[illegible]	9.9693795		log r''_0 sin 2f'_0	[illegible]
log r'' cos 2f'	[illegible]		log r''_0 cos 2f'_0	[illegible]
log tan 2f'	[illegible]		log tan 2f'_0	9.1691296
[illegible]	[illegible]		[illegible]	[illegible]
[illegible]	[illegible]		log cos 2f'_0	[illegible]
log r'	[illegible]		log r''_0	[illegible]

Section II. (continued)

In end approximation

$\log Y''$	9.7047971		$\log Y_0''$	9.9120672 n
$\log x$	8.7658041		$\log x$	8.7658041
$\log Y'$	0.0820491		$\log Y_0'$	9.7161955
$\log xY'$	8.4706012		$\log xY_0'$	8.6778713 n
δ	1.5163699		δ	1.3423336
$\log xY'$	8.8478522		$\log xY_0'$	8.6819996
δ	1.1204267		δ	1.5046190
$\log(1-xY')$	9.9869711		$\log(1-xY_0')$	0.0202049
$\log t' \div t'''$	0.3697459		$\log t_0' \div t_0'''$	9.4559319
$\log(1-xY')$	9.9682799		$\log(1-xY_0')$	9.9866186
$\log t'' \div t'''$	0.5241179		$\log t_0'' \div t_0'''$	0.1091445
$\log n \div n''$	0.3567170		$\log n_0 \div n_0''$	9.4761368
$\log 1 \div n'$	0.4923978		$\log 1 \div n_0''$	0.0957631
$\log n$	9.8643192		$\log n_0$	9.3803737
$\log r'$	0.2907439		$\log r'$	0.2907439
$\log \sin 2f''$	9.8136076		$\log \sin 2f''$	9.8136076

Section II continued

[illegible] Approximation

$\log n''$	[illegible]		$\log n''_0$	[illegible]
$\log r''$	[illegible]		$\log r'''$	[illegible]
$\log \cos 2f''$	[illegible]		$\log \cos 2f''$	[illegible]
$\log r' n$	[illegible]		$\log r' n_0$	[illegible]
$\log r' n \cos 2f''$	[illegible]		$\log r' n_0 \cos 2f''$	[illegible]
δ	[illegible]		δ	[illegible]
$\log r''' n''$	[illegible]		$\log r''' n''_0$	[illegible]
$\log r''' n'' \cos 2f''$	[illegible]		$\log r''' n''_0 \cos 2f''$	[illegible]
δ	[illegible]		δ	[illegible]
$\log r' n$	[illegible]		$\log r' n_0$	[illegible]
$\log r'' \sin 2f''$	[illegible]		$\log r''_0 \sin 2f''_0$	[illegible]
$\log r'' \cos 2f''$	0.29 04540		$\log r''_0 \cos 2f''_0$	[illegible]
[illegible]	[illegible]		$\log \tan 2f''_0$	[illegible]
[illegible]	[illegible]		f''_0	[illegible]
[illegible]	[illegible]		$\log \cos 2f''_0$	[illegible]
[illegible]	0.30 1626[illegible]		$\log r''_0$	[illegible]
[illegible]	[illegible]		$\log r''_0 \sin 2f'_0$	[illegible]
[illegible]	0.24 [illegible]		$\log r''_0 \cos 2f'_0$	[illegible]
[illegible]	[illegible]		$\log \tan 2f'_0$	[illegible]
[illegible]	[illegible]		f'_0	[illegible]
[illegible]	[illegible]		$\log \cos 2f'_0$	[illegible]
[illegible]	0.30 1626[illegible]		$\log r'_0$	[illegible]

[illegible]

[illegible] Approximation

$\log Y$	[illegible]	$\log Y_0''$	[illegible]
$\log x$	8.7659055	$\log x$	[illegible]
$\log Y$	0.0819961	$\log Y_0'$	[illegible]
$\log xY''$	8.4694331	$\log xY_0''$	[illegible]
$\log xY'$	[illegible]	$\log xY_0'$	[illegible]
$\log(1-xY')$	[illegible]	$\log(1-xY_0')$	[illegible]
$\log t'\div t''$	[illegible]	$\log t_0'\div t_0'''$	[illegible]
$\log(1-xY'')$	[illegible]	$\log(1-xY_0'')$	[illegible]
$\log t''\div t'''$	[illegible]	$\log t_0''\div t_0'''$	[illegible]
$\log n\div n''$	0.3567531	$\log n_0\div n_0''$	[illegible]
$\log t\div n''$	0.4923893	$\log t\div n_0''$	[illegible]
$\log n$	[illegible]	$\log n_0$	[illegible]
$\log r'$	0.2906155	$\log r'$	[illegible]
$\log \sin 2f''$	[illegible]	$\log \sin 2f''$	[illegible]

Section II (continued)

[illegible]

[illegible]	[illegible]5076107	$\log n''_0$	9.9042162
$\log r''$	0.3305115	$\log r'''$	0.3305115
$\log \cos 2f'$	9.8802909	$\log \cos 2f''$	9.8802909
$\log r' n$	0.1549793	$\log r' n_0$	9.6710060
$\log r' n \cos 2f''$	0.0352702	$\log r' n_0 \cos 2f''$	9.551[illegible]969
$\log r''' n''$	9.8381[illegible]	$\log r''' n''_0$	0.2[illegible]
$\log r''' n'' \cos 2f''$	9.7184131	$\log r''' n''_0 \cos 2f''$	0.1150187
$\log r' n$	0.1549793	$\log r' n_0$	9.1710060
$\log r'' \sin 2f'''$	9.6516969	$\log r''_0 \sin 2f'''_0$	0.0483025
$\log r'' \cos 2f'''$	9.2904175	$\log r''_0 \cos 2f'''_0$	0.2484742
[illegible] f''	9.[illegible]612794	$\log \tan 2f'''_0$	9.7[illegible]
$2f'$	12° 56′ 22″.5	$2f'''_0$	32° 14′ 22″.9
[illegible]			
$\log \cos 2f'$	9.9888289	$\log \cos 2f'''_0$	9.9272786
$\log r''$	0.3015886	$\log r'''_0$	0.3211956
$\log r'' \sin 2f'$	9.9685540	$\log r'' \sin 2f'_0$	9.4845807
$\log r'' \cos 2f'$	0.2488185	$\log r'' \cos 2f'_0$	0.3165379
$\log \tan 2f'$	9.7197355	$\log \tan 2f'_0$	9.1680428
$2f$	27° 40′ 35″.3	$2f_0$	8° 22′ 34″.9
$\log \cos 2f$	9.9472200	$\log \cos 2f'_0$	9.9953423
$\log r$	0.3015885	$\log r''$	0.3211956

Computation according to the formulae in Section VII.

$\log \sqrt{r_1}$	0.1645300	0.1506205	0.1645300	0.1600570	0.1645300
$\log \sqrt{r}$	0.1506205	0.1454440	0.1600570	0.1454440	0.1454440
$\log \sqrt{rr_1}$	0.3151505	[illegible]	0.3245870	0.3055010	0.3099740
$\log \cos f$	9.9871322	9.9972188	9.9988330	9.9824972	9.9719939
$\log 2 \cos f$	0.2881622	0.2982488	0.2998630	0.2835272	0.2730239
$\log 2 \cos f \sqrt{rr_1}$	0.6033127	0.5943133	0.6244500	0.5890282	0.5829979
$\log t^2$	0.2987906	9.5592988	9.3011094	0.3892456	0.6075346
$\log (2 \cos f \sqrt{rr_1})^3$	1.8099381	1.7829399	1.8733500	1.7670846	1.7489937
$\log m$	8.4888525	7.7765589	7.4277594	8.6221610	8.8885409
$\sqrt{\frac{r_1}{r}}$	0.0139095	0.0051765	0.0044730	0.0146130	0.0190860
$\log \tan (45^\circ + \omega)$	0.0069548	0.0025883	0.0022365	0.0073065	0.0095430
$45^\circ + \omega$	$45^\circ\ 27'\ 31''.5$	$45^\circ\ 10'\ 14''.6$	$45^\circ\ 8'\ 51''.1$	$45^\circ\ 28'\ 55''.0$	$45^\circ\ 37'\ 46''.0$
2ω	0 55 3.0	0 20 29.2	0 17 42.2	0 57 50.0	1 15 32.0
$\log \tan^2 2\omega$	6.4090412	5.5504050	5.4235700	6.4518906	6.6838694
ζ	1.7627968	1.9584160	1.7126276	1.8498644	1.8173054
$\log \sin^2 \frac{1}{2} f$	8.1642726	7.5040172	7.1277002	8.2955718	8.4945112
$\log (\tan^2 \omega + \sin^2 \frac{1}{2} f)$	8.1718380	7.5088210	7.1361976	8.3017550	8.5011748
$\log \cos f$	9.9871322	9.9972188	9.9988330	9.9824972	9.9719939
$\log \lambda$	8.1847058	7.5116022	7.1373646	8.3192578	8.5291809
λ	+ 0.015301	+ 0.003248	+ 0.001372	+ 0.020857	+ 0.033821

$\log \tan^2 \frac{\zeta}{2}$	8.1652726	7.5040172	7.1277002	8.2955718	8.4945112
x	+ 0.0146	+ 0.0032	+ 0.0013	+ 0.0198	+ 0.0312
ξ	+ 0.0000124	+ 0.0000006	+ 0.0000001	+ 0.0000227	+ 0.0000566
$l + \frac{\xi}{6}$	+ 0.8486343	+ 0.8365813	+ 0.8347053	+ 0.8541903	+ 0.8671542
$\log [l + \frac{\xi}{6} + \xi]$	9.9287269	9.9225085	9.9215332	9.9315662	9.9381245
$\log h$	8.5601256	7.8538504	7.5062262	8.6905948	8.9204161
ϑ	+ 0.03632	+ 0.00714	+ 0.00321	+ 0.04904	+ 0.08326
$\log \eta^2$	0.0329858	0.0068049	0.0020804	0.0436705	0.0705610
$\log \eta$	0.0164929	0.0034025	0.0015402	0.0218353	0.0352805
ϑ	0.0441365	0.0454155	0.0456017	0.0436222	0.0423529
$\log [\eta + \frac{1}{\eta}]$	0.0606294	0.0888180	0.0471419	0.0654575	0.0776334
$\log \frac{\vartheta}{\eta^2}$	8.5271398	7.8470455	7.5021458	8.6469243	8.8495551
$\log (\eta - 1)$	8.5877692	7.8955635	7.5502577	8.7123818	8.9274555
$\log \eta$	0.0164908	0.0034069	0.0015409	0.0218391	0.0352791

log m	8.4888525	7.7763589	7.4277594	8.6221610	8.8585409
log η^2	0.0329[illegible]	0.0068049	0.0030804	0.0436705	0.0705610
log $\frac{m}{\eta^2}$	8.4558667	7.7695540	7.4246790	8.5784905	8.7879799
$\frac{m}{\eta^2}$	+ 0.02857	+ 0.00588	+ 0.0026	+ 0.03789	+ 0.06137
λ	+ 0.01530	+ 0.00325	+ 0.00137	+ 0.02086	+ 0.03382
ν	+ 0.01327	+ 0.00263	+ 0.00129	+ 0.01703	+ 0.02755
ξ	+ 0.0000101	+ 0.0000004	+ 0.0000001	+ 0.0000168	+ 0.0000441
$\xi + \frac{\xi}{6}$	+ 0.8486343	+ 0.8265313	+ 0.8347053	+ 0.8541903	+ 0.8671543
log $(\xi + \nu + \frac{\xi}{6})$	9.9287257	9.9225084	9.9215332	9.9315632	9.9381185
log m	8.4888525	7.7763589	7.4277594	8.6221610	8.8585409
log η	8.5601268	7.8538505	7.5062262	8.6905978	8.9204224
η	+ 0.036318	+ 0.007143	+ 0.003208	+ 0.049045	+ 0.083257
η^2	0.0329741	+ 0.0068077	+ 0.0030785	+ 0.0436746	0.0705588
log $\frac{m}{\eta^2}$	8.4558784	7.7695512	7.4246809	8.5784864	8.7879821
$\frac{m}{\eta^2}$	+ 0.028568	+ 0.005882	+ 0.002659	+ 0.037887	+ 0.061374
λ	+ 0.015301	+ 0.003248	+ 0.001372	+ 0.020857	+ 0.033821
ν	+ 0.013267	+ 0.002634	+ 0.001287	+ 0.017030	+ 0.027555
ξ	+ 0.0000102	+ 0.0000004	+ 0.0000001	+ 0.0000168	+ 0.0000441

log η	0.0164871	0.0034039	0.0015393	0.0218373	0.0252794
η	0.0441370	0.0454154	0.0456018	0.0436220	[illegible]
[illegible]	0.0606241	0.0488193	0.0471477	0.0654593	0.0776325
[illegible]	8.5271547	7.8470428	7.5031477	8.6469232	[illegible]
[illegible]	8.5877788	7.8958621	7.5512888	8.7123805	8.9273461
[illegible]	0.0164912	0.0034069	0.0015409	0.0218391	[illegible]
log η^2	0.0329824	0.0065138	0.0030818	0.0436782	0.0705596
[illegible]	8.5158701	7.7695451	7.4846776	8.6398826	8.7879813
[illegible] η^2	+ 0.028567	+ 0.005882	+ 0.002659	+ 0.037886	+ 0.061374
log η	0.0164912	0.0034069	0.0015409	0.0218391	[illegible]
η	0.0441365	0.0454150	0.0456016	0.0436217	[illegible]
[illegible]	0.0606277	0.0488219	0.0471425	0.0654605	0.0776327
log $\frac{1}{2}\eta^2$	8.5271444	7.8470367	7.5031444	8.6469196	[illegible]
log $(\eta-1)$	8.5877721	7.8958586	7.5502860	8.7123804	[illegible]
log η	0.0164909	0.0034069	0.0015409	0.0218340	[illegible]

Second Hypothesis

$\log \sqrt{r_1}$	0.1652295	0.1508145	[illegible]	[illegible]	[illegible]
$\log \sqrt{r}$	0.1508145	[illegible]	[illegible]	0.14537[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	0.3059652	[illegible]
[illegible]	9.9872027	[illegible]	9.9988378	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.2731532
[illegible]	0.6042767	[illegible]	[illegible]	[illegible]	0.5837547
[illegible]	[illegible]	9.5592988	[illegible]	[illegible]	0.6075346
$\log(2\cos^2\sqrt{r_1})^2$	[illegible]	1.7833275	[illegible]	[illegible]	1.7512641
$\log m$	8.4859605	7.7759713	[illegible]	[illegible]	[illegible]
$\log \sqrt{\frac{r_1}{r}}$	0.0144150	[illegible]	[illegible]	[illegible]	[illegible]
$\log \tan(45^\circ+\omega)$	[illegible]	[illegible]	[illegible]	0.0076106	[illegible]
[illegible] $+\omega$	45° [illegible] 31.5	45° 10′ 46″.2	45° [illegible]	45° 30′ 7″.2	45° [illegible]
$-\omega$	[illegible]	0 21 32.4	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	7.7273603	[illegible]	[illegible]
[illegible]	[illegible]	3.5939550	[illegible]	6.4873110	6.7182012
[illegible]	8.1619236	[illegible]	[illegible]	8.2935604	8.4925646
[illegible]	8.1700856	[illegible]	[illegible]	8.3002911	8.4[illegible]108
[illegible]	[illegible]	[illegible]	[illegible]	9.9825790	[illegible]
[illegible]	8.1828829	[illegible]	[illegible]	[illegible]	8.5276876
[illegible]	+ 0.015[illegible]36	+ 0.003244	+ 0.001368	+ 0.0[illegible]	+ [illegible]

$\log \sin^2 \frac{1}{2}\gamma$	8.1619236	7.5029076	7.1258718	8.2935604	[illegible]
x	+ 0.0145	+ 0.0032	+ 0.0013	+ 0.0197	+ 0.0311
ξ	+ 0.0000122	+ 0.0000006	+ 0.0000001	+ 0.0000224	+ 0.0000563
$x + \frac{\xi}{2}$	+ 0.8485693	0.8365773	+ 0.8347013	+ 0.8541163	+ 0.8670373
$\log \xi + \frac{\xi}{2} + \frac{\xi}{2}$	9.9286873	9.9225051	9.9315211	9.9315170	[illegible]
$\log \eta$	8.5572732	7.8534662	7.5035068	6890000	8.9182327
η	+ 0.036081	+ 0.007136	+ 0.003181	+ 0.048866	[illegible]
$\log \eta^2$	0.0327493	0.0068012	0.0030528	0.0435270	[illegible]
$\log \eta$	0.0163807	0.0034006	0.0015264	0.0217635	[illegible]
$\log (\eta + \frac{1}{\eta})$	0.0005555	0.0488185	0.0471207	0.0653930	[illegible]
$\log \frac{\xi}{2}\eta$	8.5244939	7.8466650	7.4994540	8.6454790	[illegible]
$\log (\eta - 1)$	8.5850204	7.8954835	7.5465847	8.7108720	[illegible]
η^2	0.0163868	0.0034002	0.0015260	0.0217639	0.0351214

$\log \sqrt{\pi_1}$	0.1652558	0.1507943	0.1652558	0.1605978	0.1652558
$\log \sqrt{\pi}$	0.1508145	0.1453720	0.1605978	0.1453078	0.1453078
$\log \sqrt{\pi_1}$	0.3160501	0.2961021	0.3258536	0.3059056	0.3105636
$\log \cos\varphi$	9.9872080	9.9972252	9.9988387	9.9825798	9.9721285
[illegible]	0.2882380	0.2882552	0.2998687	0.2836098	0.2731585
$\log 2\cos\varphi\sqrt{\pi_1}$	0.6042881	0.5943573	0.6257223	0.5895154	0.5837221
$\log \tau^2$	0.2987906	9.5592988	9.3011094	0.3892456	0.6075346
$\log(2\cos\varphi-\sqrt{\pi_1})^3$	1.8128643	1.7830719	1.8771669	1.7685462	1.7511663
$\log m$	8.4859263	7.7762269	7.4239425	8.6206994	8.8563683
$\log \sqrt{\pi}$	0.0144615	0.0054865	0.0046580	0.0152900	0.0199480
[illegible]	0.0072308	0.0027433	0.0023290	0.0076450	0.0099740
$45^\circ+\omega$	45° 39′ 17″.6	45° 10′ 51″.4	45° 9′ 13″.1	45° 30′ 15″.4	45° 39′ 28″.3
2ω	0 57 14.0	0 21 42.8	0 18 26.2	1 0 30.8	1 18 56.6
$\log \tan^2\omega$	6.4428306	5.6009168	5.4588256	6.4912442	6.7222360
[illegible]	8.1617432	7.5030344	7.1255092	8.2935582	8.4924846
[illegible]	8.1699682	7.5083950	7.1348144	8.3003563	8.4997970
$\log \cos\varphi$	9.9872080	9.9972252	9.9988387	9.9825798	9.9721285
$\log l$	8.1827602	7.5111698	7.1359757	8.3177765	8.5276685
l	+0.015232	+0.003245	+0.001368	+0.020786	+0.03[illegible]

[illegible]	[illegible]	7.5032344	7.1255092	[illegible]	8.4[illegible]24846
x	+ 0.[illegible]	+ 0.0032	+ 0.0013	+ 0.0197	+ 0.0[illegible]11
ξ	+ [illegible]	+ 0.0000006	+ 0.0000001	+ 0.0000224	+ 0.0000563
$\xi + \frac{\xi}{6}$	+ 0.8485655	+ 0.8365783	+ 0.8347012	+ 0.8541192	+ 0.8670363
$\log[\xi + \xi + \frac{\xi}{6}]$	[illegible]	+ 9.9225072	9.9215309	9.9315301	9.9380657
$\log \xi$	[illegible]	9.8537197	7.5024116	8.6891693	8.9183026
n	+ 0.[illegible]	+ 0.007140	+ 0.003180	+ 0.048884	+ 0.082852
[illegible]	0.0[illegible]780	0.0068049	0.0030518	0.0435[illegible]85	0.070[illegible]534
[illegible]	0.0[illegible]0	0.0034025	0.0015259	0.0217693	0.0351267
[illegible]	0.0[illegible]51	0.0488208	0.0471311	0.0653982	0.0774966
[illegible]	8.5244565	7.8461148	7.4993598	8.6456308	8.8480492
[illegible]	8.5840[illegible]16	7.8057356	7.5464909	8.7110290	8.9255458
[illegible]	0.0[illegible]	0.0068056	0.0030522	0.0435422	0.070[illegible]548
[illegible]	0.0[illegible]	0.0034028	0.0015261	0.0217711	0.0351274

log m	8.4859263	7.7762269	7.4239425	8.6206994	[illegible]
log η^2	0.0327778	0.0068056	0.0030522	0.0435422	[illegible]
log m/η^2	8.4531485	7.7694213	7.4208903	8.5771572	8.7861135
[illegible]	+ [illegible]	+ 0.005881	+ 0.002636	+ 0.03[illegible]	+ 0.061110
[illegible]	+ [illegible]	+ 0.003245	+ 0.001368	+ 0.020756	+ 0.033702
x	+ [illegible]	+ 0.0026	+ 0.0013	+ 0.0170	+ 0.0274
ξ	+ 0.0000100	+ 0.0000004	+ 0.0000001	+ 0.0000167	+ 0.0000433
ξ + t	+ 0.8485653	+ 0.8365783	+ 0.8347013	+ 0.8541193	+ 0.8670363
[illegible]	[illegible]	9.9225070	9.9215309	9.9315271	9.9380592
log m	8.4859263	7.7762269	7.4239425	8.6206994	8.8563683
[illegible]	8.5572360	7.8537199	7.5024116	8.6891723	8.9183091
w	+ 0.036077	+ 0.007140	+ 0.003180	+ 0.048885	+ 0.082[illegible]

Section VIII.

The computation according to the formulae in section VIII.

First Trial.

$\log(\eta'-1)$	8.5877721	$\log(\eta'_0-1)$	7.5502869
$\log(\eta'''-1)$	7.8958586	$\log(\eta'''_0-1)$	8.7123804
$\log((\eta'-1)-(\eta'''-1))$	8.4890782	$\log((\eta'_0-1)-(\eta'''_0-1))$	8.6813982_n
$\log \eta' x$	8.7842811	$\log \eta'' x$	8.7693310
$\log Y''$	9.7047971	$\log Y''_0$	9.9120672_n
$\log(\eta''-1)$	8.9274955	$\log(\eta''-1)$	8.9274955
$\log(\eta'''-1)$	7.8958586	$\log(\eta'''_0-1)$	8.7123804
?	0.9892603	?	9.8065549
$\log((\eta''-1)-(\eta'''-1))$	8.8851189	$\log((\eta'_0-1)-(\eta'''_0-1))$	8.5192653
$\log \eta'' x$	8.8030698	$\log \eta'' x$	8.8030698
$\log Y'$	0.0820491	$\log Y'_0$	9.7161955

Section VIII. (continued)

Second Trial.

log $(\eta'-1)$	8.5850294
log $(\eta'''-1)$	7.8954835
log $((\eta'-1)-(\eta'''-1))$	8.4857214
log $\eta' x$	[illegible]
log Y''	9.7035276
log $(\eta''-1)$	8.9254791
log $(\eta'''-1)$	7.8954835
log $((\eta''-1)-(\eta'''-1))$	8.8529228
log $\eta'' x$	8.8009267
log Y'	0.0819961

log $(\eta_0'-1)$	[illegible]
log $(\eta_0'''-1)$	[illegible]
log $((\eta_0'-1)-(\eta_0'''-1))$	8.6800634
log $\eta' x$	[illegible]
log Y_0''	[illegible]
log $(\eta''-1)$	[illegible]
log $(\eta_0'''-1)$	8.7108720
log $((\eta''-1)-(\eta_0'''-1))$	8.5164031
log $\eta'' x$	8.8009267
log Y_0'	9.7154764

Section VIII (continued).

Third value of Y'.

$\log(\eta'-1)$	8.5849916	$\log(\eta'_0-1)$	7.5464909
$\log(\eta'''-1)$	7.8957356	$\log(\eta'''_0-1)$	8.7110290
$\log((\eta'-1)-(\eta'''-1))$	8.4856079	$\log((\eta'_0-1)-(\eta'''-1))$	8.6862267$_n$
$\log \eta'x$	8.7822944	$\log \eta''x$	8.7674316
$\log Y''$	9.7032135	$\log Y''_0$	9.9127951$_n$
$\log(\eta''-1)$	8.9255458	$\log(\eta''-1)$	8.9255458
$\log(\eta'''-1)$	7.8957356	$\log(\eta'''_0-1)$	8.7110290
$\log((\eta''-1)-(\eta'''-1))$	8.8829740	$\log((\eta''-1)-(\eta'''_0-1))$	8.5162625
$\log \eta''x$	8.8010329	$\log \eta''x$	8.8010329
$\log Y'$	0.0819411	$\log Y'_0$	9.7153306

Section II.

Computation according to [illegible] in Section II.

$\log \sqrt{r'''}$	0.1652644	$x_{\prime\prime}$	+0.0274
$\log \sqrt{r}$	0.1453025	z	+0.000043.
$\log \sqrt{r'''}$	0.3105669	$l_{\prime\prime} + \frac{5}{6}$	+0.8670353
$\log \cos f''$	9.9721295	$\log(\frac{5}{6} + l_{\prime\prime} + z)$	9.9380587
$\log 2\cos f''$	0.2731595	$\log \frac{\sqrt{r}}{\sqrt{r'''}}$	8.9182967
$\log 2\cos f'' \sqrt{r'''}$	0.5837264	$\frac{\sqrt{r}}{\sqrt{r'''}}$	+0.0[illegible]851
$\log \tau''^2$	0.6075346		
$\log (2\cos f'' \sqrt{r'''})^3$	1.7511792	$\log \eta^2$	0.0702541
$\log m_{\prime\prime}$	8.8563554	$\log m_{\prime\prime}/\eta_{\prime\prime}^2$	8.7561013
$\log \sqrt{\frac{r'''}{r'}}$	0.0199619	$m_{\prime\prime}'/\eta_{\prime\prime}^2$	+0.061105
$\log \tan(45^\circ + \omega'')$	0.0099810	$l_{\prime\prime}$	+0.033702
$45^\circ + \omega''$	$45^\circ\ 39'\ 20''$		
$2\omega''$	1 19 0	$\sin^2 \frac{1}{2} \eta$	+0.027406
		$\log \sin^2 \frac{1}{2} \eta$	8.4378451
$\log \tan^2 2\omega''$	6.7228594	$\log \sin^2 \frac{1}{2} \eta$	9.2189229
$\log \sin^2 \frac{1}{2} f''$	8.4924694		
$\log(\tan^2 \omega'' + \sin^2 \frac{1}{2} f'')$	8.4997533	$\frac{1}{2} \eta$	$9^\circ\ 31'\ 44''.6$
$\log \cos f''$	9.9721295	η	19 [illegible]
$\log x_{\prime\prime}'$	8.5276535		
$l_{\prime\prime}$	+0.033702		

Section X

Computation according to the [illegible] Section X.

$\frac{1}{2}(f''+g)$	19° 40′ 58″.7	$\sin\frac{1}{2}(F-G)$	0.[illegible]6.69
$\frac{1}{2}(f''-g)$	0 37 [illegible].5	$\sin\frac{1}{2}(F-G)$	9.9558[illegible]0
$2\omega'$	1 9 00		
		$\sin\frac{1}{2}q(r)$	8.4055[illegible]9
$\cos\frac{1}{2}(f''+g)$	9.9738529	$\sin\frac{1}{2}q(r)^2$	9.5284008
$\tan 2\omega'$	8.3614297		
$\cos\frac{1}{2}(f''-g)$	9.9999742	$\tan\frac{1}{2}q$	8.8771211
		$\frac{1}{2}q$	4° 18′ [illegible]″.1
$\sin\frac{1}{2}(f''+g)$	9.5273920	q	8 37 8″.2
$\sec 2\omega''$	0.0001147	$\sin\frac{1}{2}q$	9.9987704
$\sin\frac{1}{2}(f''-g)$	8.0376523	$\log(r)^2$	9.5296304
		$\log\sqrt{m_0\cos f''}$	9.1295149
$\cos\frac{1}{2}(f''+g)\tan 2\omega''$	8.3552826	$\log\sqrt{m\cos f'}$	9.5647575 check
$\sin\frac{1}{2}(f''+g)\sec 2\omega''$	9.5275067	$\log q_0$	0.0351271
$\tan\frac{1}{2}(F-G)$	8.8077759	$\log(r)^2$	9.5296304
$\cos\frac{1}{2}(F-G)$	9.9991059		
		$\frac{1}{2}(F+G)$	64° 36′ 3″.0
$\cos\frac{1}{2}(f''-g)\tan 2\omega''$	8.3614019	$\frac{1}{2}(F-G)$	3 40 31.4
$\sin\frac{1}{2}(f''-g)\sec 2\omega''$	8.0377670	F	68 17 4.4
		G	60 56 16
E	79° 59′ 30″.8	v''	88° 35′ [illegible]″.5
E'	41 52 32.4	v'	47 58 16.[illegible]

Section XI.

Computation according to formulas in section XI

v'''	88° 35′ 32″.5	$\log \sin E'$	9.8244619
v'	47 58 36.3	$\log e''$	4.4901177
E'''	79 59 30.8	$\log \sin E'''$	9.9933406
E'	41 52 32.4		
		$\log e'' \sin E'$	4.1457943
$\log \eta_0$	0.0351271	$e'' \sin E'$	5° 42′ 5″.8
$\log r'_0$	0.2906050		
$\log r'''$	0.2305287	$\log e'' \sin E'''$	4.4834580
$\log \sin 2f''$	9.8135684	$e \sin E'''$	8° 27′ 20″.9
$\log(\eta_0 r' r''' \sin 2f'')$	0.4698292	M'	36° 8′ 38″.6
$\log(\eta_0 r' r''' \sin 2f'')^2$	0.9396584	M'''	71 32 9.9
$\log r''^2$	0.6075346	$M''' - M'$	35 23 31.3
$\log \beta$	0.2321238	$\log(M''' - M')$	5.1052079
$\log \sec^2 \varphi$	0.0098678	$\log(r''' - r')$	2.0681559
$\log u$	0.3419886	$\log \tau''$	3.0370220
$\log k''$	3.7500066		
$\log k''^{3/2}$	0.5129829		
$\log \tau''$	3.0370237		
$\log \sin \varphi$	9.1756923		
$\log \sin v''$	4.6855749		
$\log e''$	4.4901174		

Section XII.

Computation according to formulas in section XII.

log tan b'	8.5[illegible]4698	log tan u'	0.14[illegible]615$_n$
log cos $(l''' - l')$	9.880[illegible]725	log tan u''	9.38[illegible]0985$_n$
log tan b' cos $(l''' - l')$	8.4038433		
log tan b'''	7.9826528	u'	125° 5' 31".2
log (tan b'' − tan b' cos $(l''' - l')$)	8.1968[illegible]91$_n$	$\Omega - v'$	206 29 [illegible]
log sin $(l''' - l')$	9.8134623	π	[illegible] 54.0
log tan i sin $(l' - \Omega)$	8.5[illegible]34698	u'''	166° 30' 27".5
log tan i cos $(l' - \Omega)$	8.2833768$_n$	$\Omega - v'''$	165 52 26.6
log tan $(l' - \Omega)$	0.1400930$_n$	π	[illegible] 22 54.1
log sin $(l' - \Omega)$	9.9084246		
		$u''' - u'$	40° 36' 56".3
$l' - \Omega$	125° 54' 54".3		
Ω	254 27 59.1	T_0	1888.0
log tan i	8.6150452	$T_0 - T'$	79.5 days
		$T''' - T_0'$	37.5 " "
i	2° 21' 36".2		
		$\mu[T_0 - T']$	24° 2' 54".32
$l''' - \Omega$	166° 31' 7".2	$\mu[T''' - T_0]$	11 20 36.95
log tan $(l''' - \Omega)$	0.1400930$_n$		
log sin i	0.0003685	$M' + \mu[T_0 - T']$	60° 11' 32".92
log tan $(l''' - \Omega)$	9.3797300$_n$	$M''' + \mu[T''' - T_0']$	60 11 [illegible]

Elements of the Island Unahita (270)

Epoch Greenwich Mean Time [illegible] 1888.0

M	=	60°	11′	32″.9	
π	=	332	22	54.0	mean Equinox and Ecliptic for 1888.0
Ω	=	254	27	59.1	
i	=	2	21	36.2	
φ	=	8	37	8.2	
μ	=	1088″.[illegible]			
$\log a$	=	0.3419886			

These elements are found to give as a correction to the normal places:

	Observed	− Computed
	$\Delta\alpha$	$\Delta\delta$
[illegible]	+ 0′.05	− 0′.5
[illegible] 10.5	+ 0′.35	[− 1′.3]
[illegible] 11.5	− 0′.26	[− 1′.3]
[illegible] 6.5	− 0′.18	− 4′.1

Part second.

Correction of the elements by means of additional observations.

We have now derived a set of elements from which we are to compute, in the next step x, y and z, the geocentric co-ordinates of the planet. They may be regarded as functions of the time and of the six elements – the co-ordinates of the sun being given.

The observed positions of the planet are now to be compared with those which are derived by calculation, and the variation of the elements to be found, which will cause the residuals between the observed and computed ones to be reduced to a minimum.

Each observation will give two equations of condition which we can imagine to be expressed in

the form

$$(u, \delta) = \varphi(e, \pi, M_0, n, i, \Omega_0)$$

where M_0 represents the mean anomaly at the epoch T. By these expressions is to be understood, that having given the quantities in the second members we can calculate those of the first.

Let the numerical values of the six elements, which we have derived be designated by

$$e_0, \pi_0, M_0, n_0, i_0, \Omega_0.$$

These quantities we know to be quite near to the true values which are to be found. Represent the minimum correction to be applied to these elements - to give the true values by

$$\Delta e_0, \Delta\pi_0, \Delta M_0, \Delta n_0, \Delta i_0, \Delta\Omega_0.$$

The corrected values of the elements will then be

$$e = e_0 + \Delta e_0$$

$$\pi = \pi_0 + \Delta\pi_0$$

$$n = n_0 + \Delta n_0$$

$$M = M_0 + \Delta M_0$$

$$i = i_0 + \Delta i_0$$

$$\Omega = \Omega_0 + \Delta\Omega_0$$

Consider these values to be substituted in (a). Then the true values of α and δ will be represented by an expression of the form

$$f(e_0 + \Delta e_0, \pi_0 + \Delta\pi_0, M_0 + \Delta M_0 + \ldots)$$

This expression may be developed in powers of the increments Δe_0, ΔM_0 etc. The term independent of these quantities will be

$$f(e_0, \pi_0, M_0, \text{etc} \ldots)$$

which will give the values of α and δ calculated by means of the uncorrected elements. If we call these values α_0 and δ_0, we will have for terms of the first order

$$\frac{df}{de_0}\Delta e_0 + \frac{df}{d\pi_0}\Delta\pi_0 + \frac{df}{dM_0}\Delta M_0 + \frac{df}{d\mu_0}\Delta\mu_0 + \frac{df}{di_0}\Delta i_0 + \frac{df}{d\Omega_0}\Delta\Omega_0 ,$$

It is essential that the variations Δe, ΔM, Δi, etc. shall be so small that terms of the second order in these quantities may be neglected. This will give us for the correct values of α and δ corrected, the equations

$$\alpha = \alpha_0 + \frac{\partial \alpha}{\partial \pi_0} \Delta \pi_0 + \frac{\partial \alpha}{\partial \epsilon_0} \Delta \epsilon_0 + \cdots$$

$$\delta = \delta_0 + \frac{\partial \delta}{\partial \pi_0} \Delta \pi_0 + \frac{\partial \alpha}{\partial \epsilon_0} \Delta \epsilon_0 + \text{&c}$$

From the observations we have given directly the values of α and δ; thus the first members of the above equations become known quantities. Putting now $\Delta\alpha$ and $\Delta\delta$ for the differences between the observed and computed values of α and δ we can write the equations

$$\Delta\alpha = \frac{\partial \alpha}{\partial \pi_0} \Delta\pi + \frac{\partial \alpha}{\partial \epsilon_0} \Delta\epsilon + \frac{\partial \alpha}{\partial \mu_0} \Delta\mu + \text{&c.},$$

$$\Delta\delta = \frac{\partial \delta}{\partial \pi_0} \Delta\pi_0 + \frac{\partial \delta}{\partial \epsilon_0} \Delta\epsilon + \frac{\partial \delta}{\partial \mu_0} \Delta\mu + \text{&c},$$

where $\Delta\alpha$ and $\Delta\delta$ stand, respectively, for $\alpha - \alpha_0$ and $\delta - \delta_0$.

Six such equations will enable us to determine $\Delta\pi$, $\Delta\epsilon$, &c., and by (b) we have at once the values of the elements themselves. But before we can utilize these equations it is necessary to first compute the values of the partial derivatives

$$\frac{\partial \alpha}{\partial \pi_0}, \quad \frac{\partial \alpha}{\partial \epsilon_0} \text{ &c.}; \quad \frac{\partial \delta}{\partial \pi_0}; \quad \frac{\partial \delta}{\partial \epsilon_0} \text{ &c.};$$

which form the coefficients of the right-hand members in the

above version

[illegible] used in making

the calculation for the partial differential coefficients of α and

δ with respect to the heliocentric co-ordinates are as follows:

XIII.

$$\cos\delta \frac{\partial \alpha}{\partial x} = -\frac{\sin\alpha}{\xi}$$

$$\cos\delta \frac{\partial \alpha}{\partial y} = \frac{\cos\alpha}{\xi}$$

$$\cos\delta \frac{\partial \alpha}{\partial z} = 0$$

$$\frac{\partial \delta}{\partial x} = -\frac{\cos\alpha \sin\delta}{\xi}$$

$$\frac{\partial \delta}{\partial y} = -\frac{\sin\alpha \sin\delta}{\xi}$$

$$\frac{\partial \delta}{\partial z} = \frac{\cos\delta}{\xi}$$

Partial differential coefficients of the heliocentric co-ordinates

with respect to the element :—

$$\frac{\partial x}{\partial \pi} = \frac{\partial x}{\partial f} = x \cot(A + u)$$

$$\frac{\partial y}{\partial \pi} = \frac{\partial y}{\partial f} = y \cot(B + u)$$

$$\frac{\partial z}{\partial \pi} = \frac{\partial z}{\partial f} = z \cot(C + u)$$

$$\frac{\partial x}{\partial \alpha} = -\frac{dy}{d\xi} - y\cos\varepsilon - z\sin\varepsilon$$

$$\frac{\partial y}{\partial \alpha} = -\frac{dx}{d\xi} + x\cos\varepsilon$$

$$\frac{\partial z}{\partial \alpha} = -\frac{dz}{d\xi} + x\sin\varepsilon$$

$$\frac{\partial x}{\partial t} = r\sin u\cos\omega$$

$$\frac{\partial y}{\partial t} = r\sin u\cos b$$

$$\frac{\partial z}{\partial t} = r\sin u\cos c$$

$$\frac{\partial x}{\partial r} = \frac{x}{r} \qquad \frac{\partial y}{\partial r} = \frac{y}{r} \quad ; \quad \frac{\partial z}{\partial r} = \frac{z}{r}$$

$$\frac{\partial r}{\partial \eta} = -a\cos\eta\cos\xi$$

$$\frac{\partial \xi}{\partial \eta} = \left(\frac{1}{\cos\eta} + \tan\eta\cos\xi\right)\sin\xi$$

$$\frac{\partial r}{\partial \Psi_0} = a\tan\eta\sin\xi$$

$$\frac{\partial \xi}{\partial \Psi_0} = \frac{a^2\cos\eta}{r^2}$$

$$\frac{\partial r}{\partial \mu} = a\tan\eta\sin\xi\,(1-T) - \frac{2}{3}\frac{r}{\mu}\,[illegible]$$

$$\frac{\partial \xi}{\partial \mu} = \frac{a^2\cos\eta}{r^2}\,(1-T)$$

$$\cos a = \sin i \sin \theta$$

$$\cos b = -\cos\theta \sin i \cos \varepsilon - \cos i \sin \varepsilon$$

$$\cos c = -\cos\theta \sin i \sin \varepsilon + \cos i \cos \varepsilon$$

$$\cos \delta \frac{\partial u}{\partial \pi} = \cos\delta \frac{\partial u}{\partial x} \cdot \frac{\partial x}{\partial \pi} + \cos\delta \frac{\partial u}{\partial y} \cdot \frac{\partial y}{\partial \pi}$$

$$\frac{\partial \delta}{\partial \pi} = \frac{\partial \delta}{\partial x} \cdot \frac{\partial x}{\partial \pi} + \frac{\partial \delta}{\partial y} \cdot \frac{\partial y}{\partial \pi} + \frac{\partial \delta}{\partial z} \cdot \frac{\partial z}{\partial \pi}$$

$$\cos \delta \frac{\partial u}{\partial \theta} = \cos\delta \frac{\partial u}{\partial x} \cdot \frac{\partial x}{\partial \theta} + \cos\delta \frac{\partial u}{\partial y} \cdot \frac{\partial y}{\partial \theta}$$

$$\frac{\partial \delta}{\partial \theta} = \frac{\partial \delta}{\partial x} \cdot \frac{\partial x}{\partial \theta} + \frac{\partial \delta}{\partial y} \cdot \frac{\partial y}{\partial \theta} + \frac{\partial \delta}{\partial z} \cdot \frac{\partial z}{\partial \theta}$$

$$\cos \delta \frac{\partial u}{\partial i} = \cos\delta \frac{\partial u}{\partial x} \cdot \frac{\partial x}{\partial i} + \cos\delta \frac{\partial u}{\partial y} \cdot \frac{\partial y}{\partial i}$$

$$\frac{\partial \delta}{\partial i} = \frac{\partial \delta}{\partial x} \cdot \frac{\partial x}{\partial i} \cdot \frac{\partial \delta}{\partial y} \cdot \frac{\partial y}{\partial i} + \frac{\partial \delta}{\partial z} \cdot \frac{\partial z}{\partial i}$$

$$\cos \delta \frac{\partial u}{\partial r} = \cos\delta \frac{\partial u}{\partial x} \frac{\partial x}{\partial r} + \cos\delta \frac{\partial u}{\partial y} \cdot \frac{\partial y}{\partial r}$$

$$\frac{\partial \delta}{\partial r} = \frac{\partial \delta}{\partial x} \cdot \frac{\partial x}{\partial r} + \frac{\partial \delta}{\partial y} \frac{\partial y}{\partial r} + \frac{\partial \delta}{\partial z} \cdot \frac{\partial z}{\partial r}$$

$$\cos \delta \frac{\partial u}{\partial \eta} = \cos\delta \frac{\partial u}{\partial r} \frac{\partial r}{\partial \eta} + \cos\delta \frac{\partial u}{\partial \tau} \frac{\partial \tau}{\partial \eta}$$

$$\frac{\partial \delta}{\partial \eta} = \frac{\partial \delta}{\partial r} \cdot \frac{\partial r}{\partial \eta} + \frac{\partial \delta}{\partial \tau} \frac{\partial \tau}{\partial \eta}$$

$$\cos\delta \frac{\partial \alpha}{\partial M_0} = \cos\delta \frac{\partial \alpha}{\partial r} \cdot \frac{\partial r}{\partial M_0} + \cos\delta \frac{\partial \alpha}{\partial f} \cdot \frac{\partial f}{\partial M_0} .$$

$$\frac{\partial \delta}{\partial M_0} = \frac{\partial \delta}{\partial r} \cdot \frac{\partial r}{\partial M_0} + \frac{\partial \delta}{\partial f} \cdot \frac{\partial f}{\partial M_0}$$

$$\cos\delta \frac{\partial \alpha}{\partial \mu} = \cos\delta \frac{\partial \alpha}{\partial r} \cdot \frac{\partial r}{\partial \mu} + \cos\delta \frac{\partial \alpha}{\partial f} \cdot \frac{\partial f}{\partial \mu}$$

$$\frac{\partial \delta}{\partial \mu} = \frac{\partial \delta}{\partial r} \cdot \frac{\partial r}{\partial \mu} + \frac{\partial \delta}{\partial f} \cdot \frac{\partial f}{\partial \mu} .$$

First we make the computation for the precession of the elements π, Ω, and i, to the mean equinox and ecliptic for the epoch 1887.0, according to the following formulae :—

XII.

$$\delta' \Omega = -0''.49\, t \sin [\Omega + 7^\circ\tfrac{1}{2}] \cot i .$$

$$\Delta \pi = \text{precession} = 50''.4$$

$$\Delta \Omega = \delta' \Omega$$

$$\Delta i = +0''.49\, t \cos (\Omega + 7^\circ\tfrac{1}{2})$$

Section XII

T = 1888.0

π	35°	2'	54".0
i	2	21	6.2
☊	254	27	59.1
(☊ + 7½°)	261	57	59.1
cos(☊ + 7½°)	9.14556		
log 0".49	9.69020		
sin(☊ + 7½°)	9.99571$_n$		
cot i	138496		
δ'☊	107057		
δ'☊	+ 11".77		
Δπ	+ 50".24		
Δ☊	+ 62".01		
Δi	− 0'.07		

x) Mean Equinox and Ecliptic for 1888.0

T = 1887.0

π	35°	2'	5".5
☊	254	6	57.1
i	2	21	6.3
φ	8°	37'	8".2
μ	1088'.99		
log a	0.3419556		
log μ	3.0370[illegible]0		
log cos φ	9.9950676		
log sin φ	9.1756923		
log sin φ / 1"	4.4901174		
π − ☊	77°	55'	6".7
i	2	21	56.3
☊	254	20	57.1
ε	23	27	14.1

xx) Mean Equinox and Ecliptic for 1887.0

Computation of Ephemeris.

With the preceding deduced elements for the respective epochs 1887.0 and 1888.0 we will now compute the geocentric co-ordinates α, δ and ρ for each date that we compute directly, the co-ordinates we also compute the corresponding correction to be made for Aberration time, which is to be subtracted from the time of observation.

The computation of the Ephemeris will be made according to the following formulae: —

IV.

$$\cot A = -\tan \Omega \cos i$$

$$\cot B = \frac{\cos i}{\tan \Omega \cos E_0} \cdot \frac{\cos(E_0 + \varepsilon)}{\cos \varepsilon}$$

$$\cot C = \frac{\cos i}{\tan \Omega \cos E_0} \cdot \frac{\sin(E_0 + \varepsilon)}{\sin \varepsilon}$$

$$\sin a = \frac{\cos \Omega}{\sin A}$$

$$\sin b = \frac{\sin \Omega \cos \varepsilon}{\sin B}$$

$$\sin c = \frac{\sin \Omega \sin \varepsilon}{\sin C}$$

And for a check

$$u = \frac{\sin c \sin (C - B)}{\sin a \cos A}$$

$$x = r \sin a \sin (A + u)$$

$$y = r \sin b \sin (B + u)$$

$$z = r \sin c \sin (C + u)$$

$$\tan \alpha = \frac{y + Y}{x + X} \qquad \tan \gamma = \frac{z + Z}{x + X} \cos \alpha - \frac{z + Z}{y + Y} \sin \alpha$$

$$E = M + e \sin M$$

$$u = f + \pi - \Omega$$

$$r \sin f = a \cos \varphi \sin E$$

$$r \cos f = a [\cos E - \sin \varphi]$$

Formula for Aberration time

$$T = \text{[illegible]}$$

Computation of the Constants [illegible] in Section XI.

T = 1837.0

i	2° 21' 36".3	[illegible] A	0.5551509 n
☊	[illegible]	A	344° 26' 11".9
ε	[illegible]		
		[illegible] ☊	[illegible] n
tan i	8.6150504	[illegible] A	9.4256269 n
cos ☊	[illegible] n	sin a	9.9996582
tan E_0	[illegible] n		
		[illegible]	[illegible]
E_0	171° 15' 36".7	sin ☊	9.9838035 n
$E_0 + \varepsilon$	194 42 50.8	cos ε	9.9625495
[illegible] $E_0 + \varepsilon$)	9.9855187 n	sin ☊ cos ε	[illegible]
[illegible]	9.9625495	sin B	9.9816925 n
[illegible]	[illegible] n	sin b	9.9646605
sin ($E_0 + \varepsilon$)	[illegible]	sin ☊ sin ε	[illegible]
[illegible]	9.5998955	sin C	9.9931122 n
[illegible]	9.8049316 n	sin c	[illegible]
[illegible] E_0	9.9949277 n	Check:	
tan ☊	0.5555185		
cos i	9.9996215	sin b sin c	[illegible]
cos E_0 tan ☊	[illegible] n	sin a	9.9996582
[illegible]	[illegible]		[illegible]
		C − B	[illegible]
[illegible] B	[illegible]	[illegible] C − B)	[illegible]
B	[illegible]	cos A	[illegible]
			9.0594622
[illegible] C	[illegible]	tan i	[illegible]
C	[illegible]		

[illegible]	Oct. 8.5	Oct. 12.5	Oct. 16.5	Oct. 20.5	Oct. 24.5
Δ	34° 56′ 2″.7	36° 8′ 38″.7	37° 21′ 14″.6	38° [illegible] 50″.5	39° 46′ 26″.5
E_0	40 32 0.0	41 53 40.0	43 15 15.0	44 36 40.0	45 57 45.0
sin E_0	9.8[illegible]401	9.8246206	[illegible]	9.8465172	9.8566594
δ sin E_0	4.3[illegible]0575	4.3147380	[illegible]	4.3366246	4.3467768
	5° [illegible]4′ 49″.0	5° 44′ 1″.3	5° 53′ 1″.5	6° 1′ 48″.7	6° 10′ 21″.7
E_1	40 30 51.7	41 52 40.0	43° 14′ 16.1	44 35 39.2	45 56 48.2
sin E_1	9.8126718	9.8244798	9.8357083	9.8463874	9.8565437
δ sin E_1	4.3027892	4.3145972	4.3258257	4.3365048	4.3466611
	5° 34′ 41″.2	5° 43′ 54″.7	5° 52′ 55″.1	6° 1′ 42″.[illegible]	6° 10′ 15″.8
E	40 30 43	41 52 33.4	43 14′ [illegible]	44 35 3[illegible]	45 56 42.3
E	40 30 42.[illegible]	41 52 3[illegible]	43 14 [illegible]	44 35 [illegible]	45 56 41.6
log sin E	9.8126501	9.8244622	9.8356921	9.8463720	9.8565[illegible]
log cos E	9.8809684	9.8719200	9.8624538	9.8525540	9.8422034
cos E	+0.760271	+0.744595	+0.728541	+0.712121	+0.695350
log (cos E − sin q)	0.7856209	0.7743220	9.7624378	9.7499364	9.7367852
log r sin f	0.1497063	0.1615184	0.1727483	0.1834282	0.1935865
sin u cos f	9.8602525	9.8709145	9.8809700	9.8904521	9.8993899
log cos f	0.1276095	0.1163106	0.1044264	0.0919250	0.0787738
log tan f	0.0220968	0.0452078	0.0683219	0.0915032	0.1148127
f	46° 27′ 25″.1	47° 58′ 36″.2	49° 29′ 18″.0	50° 59′ 30″.4	52° 29′ 12″.5
log r	0.2894538	0.2906039	0.2917783	0.2929761	0.2941966
u	124° 22′ 31″.8	125° 53′ 42″.9	127° 24′ 24″.7	128° 54′ 37″.1	130° 24′ 19″.2
$A + u$	108° 48′ 43″.7	110° 19′ 54″.8	111° 50′ 36″.6	113° 20′ 49″.0	114° 50′ 31″.1
$B - u$	17 51 20.7	19 22 31.8	20 53 13.6	22 23 26.0	23 53 8.1
$C + u$	24 11 53.1	25 43 4.2	27 13 46.0	28 43 58.4	30 13 40.5

[illegible]	[illegible]	Cel. 12.	Cel. 16.5	[illegible]	[illegible]
log x sin a	[illegible]	[illegible]	0.2914365	0.2926343	[illegible]
log sin (A+u)	[illegible]	[illegible]	9.9676433	9.9629004	[illegible]
log x	[illegible]	0.2673241	0.2590798	0.2555347	0.2516870
x	+ 1.841916	+ 1.829465	+ 1.815849	+ 1.801087	+ 1.785200
X	− 0.962682	− 0.941045	− 0.914898	− [illegible]	− 0.849541
x + X	+ 0.879234	+ 0.888419	+ 0.900951	+ 0.916740	+ 0.935658
sin b	[illegible]	[illegible]	[illegible]	0.2576366	0.2588571
sin (B+u)	[illegible]	[illegible]	[illegible]	9.3808315	9.6073602
log y	[illegible]	9.7760855	[illegible]	9.8384681	9.8662173
y	− 0.550449	+ [illegible]	+ 0.643476	+ [illegible]	+ 0.734881
Y	− [illegible]	− [illegible]	− 0.261553	− 0.418437	− 0.473288
y + Y	+ 0.307580	+ [illegible]	+ [illegible]	+ [illegible]	+ [illegible]
sin c	9.8800406	9.8811907	[illegible]	[illegible]	[illegible]
sin (C+u)	9.6126700	9.6374292	[illegible]	9.6818985	9.7019486
log z	9.4927106	[illegible]	9.5428083	9.5654614	[illegible]
z	+ 0.310964	+ 0.330080	+ 0.348986	+ 0.367672	+ 0.386128
Z	− 0.105769	− 0.131423	− 0.156855	− 0.181535	− 0.205335
z + Z	+ 0.205595	+ 0.198657	+ 0.192130	+ 0.186131	+ 0.180793

[illegible]	Oct. 8.5	Oct. 12.5	Oct. 16.5	Oct. 20.5	Oct. 24.5
log (y + Y)	9.4879581	9.4686796	9.4501[illegible]	9.4329020	[illegible]
log (x + X)	9.9441045	9.9486181	9.9547014	9.9622464	[illegible]
log tan α	9.5438526	9.5200615	9.4954291	9.4706556	[illegible]
(arc) α	19° 16' 52".4	18° 19' 25".5	17° 22' [illegible]	16° [illegible]	[illegible]
(time) α	1h 17m 7s.49	1h 15m 17s.70	1h 9m 30s.19	[illegible]	[illegible]
	+ 1.71				
log (z + Z)	9.3130136	9.2981050	9.2835963	[illegible]	9.2571816
log (x + X)	9.9441045	9.9486181	9.9547014	[illegible]	[illegible]
[illegible]	9.3689091	9.3494869	9.3288949	[illegible]	9.2860642
[illegible] α	9.9749302	9.9774013	9.9797153	[illegible]	[illegible]
log tan δ	9.3438393	9.3268882	9.3086102	[illegible]	[illegible]
δ	12° 26' 48".1	11° 59' 3".4	11° 30' 13".7	11° 1' [illegible]	10° [illegible]
	+ 7.7	+ 8.0			
log (z + Z)	9.3130136	9.2981050	9.2835963	[illegible]	9.2571816
log sin δ	9.3335102	9.3173178	9.2997971	[illegible]	9.2623291
log Δ	9.9795034	9.9807872	9.9837992	[illegible]	9.9948525
log [illegible] T	7.7400	7.7413	7.7443	[illegible]	[illegible]
lib. t.	−0.0050	−0.0055	−0.0056	−0.0056	[illegible]

[illegible]	[illegible]	[illegible]	Nov 5.5	[illegible]	Nov 13.5
[illegible]	40° 59' 2.4	42° 11' 38".4	43° 24' 14".3	44° 36' 50".2	45° 49' 26.2
E_0	47 18 45.0	48 [illegible]	49 59 45.0	51 20 0.0	52 [illegible] 50.0
[illegible] E_0	9.8662243	9.8754965	9.8842274	9.8925365	9.9004[illegible]
[illegible] E_0	4.3564417	4.3656139	4.3743448	4.3826539	4.3905345
	6° 18' 41".7	6° 26' 46".7	6° 34' 38".[illegible]	6° 42' 15".4	6° 49' [illegible]
E_1	47 17 [illegible]	48° 38' 25.1	49° 58' 52".3	51 19 5.6	52° 39' [illegible]
sin E_1	9.8662060	9.8753947	9.8841343	9.8924448	9.9003[illegible]
c sin E	4.3563234	4.3655121	4.3742517	4.3825622	4.3904[illegible]
	6° 18' 35".6	6° 26' 41".3	6° 34' 32".9	6° 42' 10".3	6° 49' [illegible]
E_2	47 17 38.0	48 38 19.7	49 58 47.2	51 19 0.5	52 [illegible] 59.[illegible]
E	47 17 37.0	48 38 19.1	49 58 46.7	51 19 0.0	52 [illegible] 58.[illegible]
[illegible] E	9.8661028	9.8753836	9.8841245	9.8924354	9.9003[illegible]
[illegible] E	9.8313838	9.8200739	9.8082514	9.7958909	9.7829644
[illegible] E	+0.678241	+0.660806	+0.643060	+0.625016	+0.606689
log [cos E − sin C]	0.7229456	9.7083733	9.6930213	9.6768344	9.6597499
log r sin f	0.2032490	0.2124395	0.2211807	0.2294916	0.2373911
sin or cos	9.9078110	9.9157407	9.9232014	9.9302146	9.9367999
log r cos f	0.0649342	0.0583619	0.0350099	0.0188230	0.0017[illegible]
log tan f	0.1383148	0.1620779	0.1861708	0.2106686	0.2356526
f	53° 58' 24".2	55° 27' 5".3	56° 55' 15".2	58° 22' 53".8	59° 50' 0".9
log r	0.2954350	0.2966991	0.2979793	0.2992770	0.3005912
u	131° 53' [illegible]	133° 22' 12".0	134° 50' 21".9	136° 18' 0".5	137° 45' 7".6
A + u	116° 19' 42".8	117° 48' 23".9	119° 16' 33.8	120° 44' 12".4	122° 11' 19.5
B + u	25 22 19.8	26 51 0.9	28 19 10.8	29 46 49.4	31 13 56.5
C + u	31 42 52.2	33 11 [illegible]	34 39 43.2	36 7 21.8	37 [illegible]

[illegible]	[illegible]	Nov. 1.5	[illegible]	[illegible]	[illegible]
log r sin u	[illegible]	0.2963573	[illegible]	[illegible]	[illegible]
log sin (A+u)	[illegible]	9.9467111	9.9406528	9.9342582	[illegible]
log x	[illegible]	0.2420684	[illegible]	[illegible]	[illegible]
x	+ 1.768206	+ 1.750122	+ 1.730973	+ 1.710777	[illegible]
X	− 0.810656	− [illegible]	− 0.721385	− 0.671377	[illegible]
x+X	+ 0.957550	+ 0.982247	+ [illegible]	+ 1.039399	[illegible]
log r sin b	0.2600385	0.2613596	0.2626398	0.2639375	[illegible]
log sin (B+u)	9.6310470	9.6548118	9.6761359	9.6960740	[illegible]
log y	9.8920455	9.9161714	[illegible]	9.9600115	[illegible]
Y	[illegible]	+ 0.824463	+ 0.868512	+ 0.912035	+ 0.955012
Y	− 0.525841	− 0.575851	− 0.623087	− 0.667314	− 0.708291
y+Y	+ 0.254070	+ 0.248611	+ 0.245424	+ 0.244720	+ 0.246720
log r sin c	[illegible]	[illegible]	9.8885661	[illegible]	8.8911780
log sin (c+u)	[illegible]	[illegible]	9.7549093	9.7704962	[illegible]
log z	9.6067520	9.6256342	[illegible]	[illegible]	[illegible]
z	[illegible]	[illegible]	+ 0.440023	+ 0.457467	[illegible]
Z	[illegible]	− 0.249836	[illegible]	− 0.289513	− 0.307289
z+Z	+ 0.176207	+ 0.172477	+ 0.169695	+ 0.167954	+ 0.167345

(1887)	[illegible]	[illegible]	Mer. 5.5	[illegible]	[illegible]
log (x + Y)	[illegible]	[illegible]	9.3899179	[illegible]	[illegible]
log (x + X)	[illegible]	[illegible]	0.0041441	[illegible]	[illegible]
log tan α	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(arc) α	14° [illegible]	14° 12' 12".5	13° 39' 47".6	[illegible]	[illegible]
(time) α	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
log (z + Z)	[illegible]	9.2367312	9.2296690	9.2251904	[illegible]
log (x + X)	[illegible]	[illegible]	0.0041441	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	9.2255249	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9.9557817
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	10° [illegible]	[illegible]	9° 16' [illegible]	[illegible] 56' 19".1	9° 39' 14".6
					+ 10.1
log (z + Z)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.0025982	0.0119065	[illegible]	[illegible]	[illegible]
[illegible]	7.7613$_n$	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	− 0.0058	− 0.0054	− 0.0061	− 0.0062	− 0.0064

1887)	[illegible]	Nov. [illegible]	[illegible]	[illegible]	[illegible]
M	[illegible]	[illegible]	49° 27' 14".0	[illegible]	51° 52' 25".8
E_0	53 59 30.0	[illegible]	56 38 0.0	[illegible]	59° 15' 35".0
sin E_0	[illegible]	[illegible]	9.9217738	[illegible]	9.9342425
2" sin E_0	[illegible]	[illegible]	4.4118912	[illegible]	[illegible]
	6° 56' 45".1	7° 3' 28".7	7° 10' 16".1	7° 16' 41".0	[illegible]
E_1	53 58' 47".2	55° 18' 16".8	56° 37' 30".1	57° 56' 31".5	59° 15' 13".0
[illegible] E_1	9.9078462	[illegible]	9.9217323	[illegible]	9.9342160
[illegible] E_1	4.3978636	4.4050899	[illegible]	[illegible]	[illegible]
	6° 56' 41".4	7° 3' 35".0	7° 10' [illegible]	7° 16' 37".7	[illegible]
E_2	53° 58' 43".5	55° 18' 13".1	56° 37' 27".7	57° 56' [illegible]	[illegible]
E	53° 58' 43".1	[illegible]	56° 37' 27".4	57° 56' 27".3	[illegible]
[illegible] E	[illegible]	9.9149664	[illegible]	[illegible]	[illegible]
[illegible] E	9.7694414	[illegible]	[illegible]	9.7249256	[illegible]
[illegible] E	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9.5579653
log r sin f	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
sin or cos	[illegible]	[illegible]	9.9541632	9.9592056	9.9638988
[illegible]	[illegible]	9.9645829	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0.3144486	[illegible]	[illegible]
f	61° 16' 36".3	[illegible]	64° [illegible] 11".3	65° 33' 10".6	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	0.3059909	[illegible]
u	139° 11' 43".0	140° 27' 46".6	[illegible]	143° 28' 17".3	[illegible]
[illegible] + u	123° 37' 54".9	125° 3' 58".5	126° [illegible]	127° 54' 29".2	[illegible]
[illegible] + u	32° 40' 31".9	34° 6' 35".5	35° 32' 6".9	36° 57' [illegible]	[illegible]
[illegible] + u	39° 1' 4".3	40° 27' 7".9	41° 52' 39".3	43° 17' 38".6	[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	0.3029227	[illegible]	0.3056491	[illegible]
[illegible]	[illegible]	9.9130124	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
x	+1.667332	+1.644126	[illegible]	[illegible]	+1.568857
X	−0.561722	−0.502613	[illegible]	[illegible]	[illegible]
x+X	+1.105610	+1.141512	[illegible]	[illegible]	+1.257070
[illegible]	0.2665812	0.2679250	[illegible]	0.2706514	0.2720316
[illegible] (c+u)	[illegible]	9.7487937	[illegible]	9.7789770	9.7928052
log y	9.9988791	0.0167187	[illegible]	[illegible]	[illegible]
y	[illegible]	[illegible]	+1.080464	[illegible]	+1.161012
Y	[illegible]	−0.779610	−0.809580	−0.835565	[illegible]
y+Y	+0.251630	+0.259637	[illegible]	+0.285494	+0.303568
log r sin c	[illegible]	9.8938513	9.8952084	9.8965777	[illegible]
log sin (c+u)	9.7990389	[illegible]	[illegible]	9.8361613	[illegible]
log z	[illegible]	[illegible]	[illegible]	9.7327390	[illegible]
z	+0.491526	[illegible]	[illegible]	+0.540429	[illegible]
Z	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
z+Z	[illegible]	[illegible]	+0.173189	+0.177916	[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	9.4143666	9.4327825	[illegible]	9.4822567
[illegible]	0.0436019	0.0574807	0.0714822	0.0854784	0.0993627
[illegible]	9.3571614	9.3568859	9.3613003	9.3701186	9.3825940
[illegible]	12° 49' 18".4	12° 48' 50".1	12° 56' 25".6	13° 11' 48".0	13° 34' 4".6
(time) α	0h 51m 17.[illegible]	0h 51m 15".34	0h 51m 45".71	0h 52m 47.[illegible]	0h 54m 18.[illegible]
	[illegible]	+ 1.98	[illegible]	[illegible]	[illegible]
log (z + Z)	9.2252214	9.2301691	9.2385215	9.2502150	9.2650951
log (x + X)	0.0436019	0.0574807	0.0714822	0.0854784	0.0993627
[illegible]	9.1816195	9.1726884	9.1670393	9.1647366	9.1657324
log cos α	9.9890336	9.9890472	9.9888279	9.9883770	9.9876923
log tan δ	9.1706531	9.1617356	9.1558672	9.1530136	9.1534247
δ	8° 25' 34".1	8° 15' 26".2	8° 8' 52".6	8° 5' 49".7	8° 6' 10".3
	[illegible]	+ 10.6	+ 10.8	[illegible]	+ 11.[illegible]
log (z + Z)	9.2252214	9.2301691	9.2385215	9.2502150	9.2650951
log sin δ	9.1659394	9.1572099	9.1514606	9.1487624	9.1490671
log Δ	0.0592820	0.0729592	0.0870609	0.1014526	0.1160[illegible]
log abbr.	7.8198[illegible]	7.8[illegible]	7.8476	7.8620	7.876[illegible]
Abbr.	−0.0066	−0.0068	−0.0070	−0.0073	−0.007[illegible]

(1887)	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	54° 17' 37".7	55° 20' 12".6	[illegible]
E	60 34 20.0	61 52 40.0	63 10 40.0	[illegible]
[illegible]	9.9400060	9.9454411	9.9505649	[illegible]
[illegible]	[illegible]	4.4355585	4.4406823	[illegible]
	7° 28' 40".0	7° 34' 22".0	[illegible]	[illegible]
E	60 33 44.7	61 51 59.7	[illegible]	64 27 42.6
E	9.9399641	9.9453957	9.9505214	[illegible]
[illegible] E	4.4300815	4.4355131	4.4406388	[illegible]
	7° 28' 40".4	7° 34' 19".2	7° 39' [illegible]	[illegible]
E	60 33 42.1	61 51 56.9	[illegible]	[illegible]
E	60 33 41.9	61 51 56.7	63 9 56.2	64 27 40.6
[illegible] E	9.9399608	[illegible]	[illegible]	[illegible]
log cos E	9.6915120	9.6735177	9.6545741	9.6345992
cos E	+0.[illegible]	+0.471539	+0.451413	+0.431121
log [cos E − sin y]	9.5335497	9.5074201	9.4793607	[illegible]
log r sin f	0.2770170	0.2824485	[illegible]	[illegible]
sin or cos	[illegible]	[illegible]	9.9760067	[illegible]
log r cos f	[illegible]	[illegible]	[illegible]	[illegible]
log tan f	0.[illegible]14787	0.4330398	0.4662251	0.5013092
f	68° 21' 32".8	69° 44' 55".6	71° 7' 46".0	72° 30' 4".2
[illegible]	0.3087613	[illegible]	[illegible]	[illegible]
u	146° 16' 39".5	147° 40' 2".3	149° 2' 52".7	150° 25' 11".0
[illegible] + u	130° 42' 51".4	132° 6' 14".2	133° 29' 4".6	[illegible]
[illegible] + u	[illegible] 45 [illegible].4	41° 8' 51".2	42 31 41.6	[illegible]
[illegible] + u	46 6 0.8	47° [illegible]' 23".2	48 52 14.0	[illegible]

(1887)	[illegible]	[illegible]	[illegible]	Dec 19 s
log sin u	[illegible]	0.3098187	0.[illegible]112259	0.[illegible]126402
log sin (A+u)	[illegible]	[illegible]	9.8606729	9.8505710
log x	[illegible]	0.1801814	0.1718988	0.1632112
x	+ 1.541958	+ 1.514194	+ 1.485589	+ 1.456167
X	− 0.244661	− 0.176310	− 0.107064	− 0.037288
x+X	+ 1.297296	+ 1.337884	+ 1.378525	+ 1.418879
[illegible]	[illegible]	0.2748210	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	9.8299167	[illegible]
[illegible]	0.0792928	0.0930472	0.1061449	[illegible]
y	+ 1.200308	+ 1.238931	+ 1.276865	+ 1.314097
Y	− 0.875101	− 0.888425	− 0.897327	− 0.901746
y+Y	+ 0.325207	+ 0.350506	+ 0.379539	+ 0.412351
log r sin c	9.8993481	9.9007473	9.9021545	9.9035658
log sin (C+u)	9.8576664	9.8675606	9.8769250	9.8857885
log z	9.7570145	9.7683079	9.7790795	9.7893573
z	+ 0.571498	+ 0.586554	+ 0.601284	+ 0.615683
Z	− 0.379661	− 0.385441	− 0.389304	− 0.391224
z+Z	+ 0.191836	+ 0.201113	+ 0.211980	+ 0.224458

[illegible]	[illegible]	Dec. 11 5	[illegible]	Dec. 19
log (y + Y)	[illegible]	9.5446954	9.5792570	9.6152671
log (x + X)	0.1130392	0.1264185	0.1394147	0.1519454
log tan α	9.3991207	9.4182769	9.4398422	9.4632217
(arc) α	14° 4' 22".6	14° 40' 50".6	15° 23' 36".4	16° 12' 17".2
[illegible]	0h 56m 17s.51	0h 58m 43s.37	1h 1m 34s.43	1h 4m 49s.14
log (z + Z)	9.2829313	9.3034402	9.3262949	9.3511361
log (x + X)	0.1130392	0.1264185	0.1394147	0.1519454
÷	9.1698921	9.1770217	9.1868802	9.1991907
[illegible]	9.9867659	9.9855850	9.9841337	9.9823935
[illegible]	9.1556580	9.1626067	9.1710139	9.1815842
[illegible]	8° 9' 45".4	8° 16' 25".1	8° 25' 59".0	8° 38' 15".[illegible]
log (z + Z)	9.2829313	9.3034402	9.3262949	9.3511361
[illegible]	9.1522364	9.1580630	9.1662927	9.1706301
log Δ	0.1306949	0.1453772	0.1600022	0.1745058
[illegible]	7.8912	7.9050	7.9205	7.9350
[illegible]	−0.0079	−0.0080	−0.0083	−0.0086

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	sin A	9.4281579$_n$
[illegible]	[illegible]	sin a	9.9996578
[illegible]	[illegible]	sin ε	9.5998931
[illegible]	9.4[illegible]$_n$	sin δb	9.9838399$_n$
[illegible]	9.1872296$_n$	cos ε	9.9625499
		sin δb cos ε	9.9463898$_n$
E_0	171° 15′ 3″.6	sin B	9.9817[illegible]11$_n$
$E_0 + \varepsilon$	194° 42′ 17″.2	sin b	9.9646587
cos [$E_0 + \varepsilon$]	9.9855372$_n$		
[illegible]	9.96[illegible]499	sin δb sin ε	9.5837330$_n$
[illegible]	0.0229873$_n$	sin C	9.99[illegible]1[illegible]00$_n$
sin [$E + \varepsilon$]	9.404[illegible]6	sin c	9.5905970
sin ε	9.5998931		
[illegible]	9.8046645$_n$	sin b sin c	9.5[illegible]
[illegible] E_0	9.9940170$_n$	sin a	9.9996578
tan δb	0.5560[illegible]	÷	9.5[illegible]
cos i	9.9996[illegible]		
cos E_0 tan δb	0.5509412$_n$	C − B	6° 20′ 33″.6
[illegible]	9.4486903$_n$	sin (C − B)	9.0432619
		cos A	9.9838134
cos B	9.4716776	÷	9.0594485
B	253° 29′ 50″.6	tan i	8.6150463
cos C	9.2[illegible]		
C	259° 50′ 24″.[illegible]	M	60° 11′ 32″.9
cos A	0.5[illegible]$_n$		
A	344° [illegible]′ 13″.9	π − δb	[illegible]° [illegible]′ 54″.9

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
M_1	60° 56' 55".4	61° 51' 22".3	62° [illegible]	63° 40' 16".2	64° [illegible]
E_1	68 57 45.0	69° 52' 12".0	70° [illegible]	71 49 41.0	72° 46' 50.0
[illegible] E_1	9.9700425	9.9727646	[illegible]	9.9777801	[illegible]
[illegible] E	4.4601599	4.4628820	[illegible]	[illegible]	[illegible]
	8° 0' 50".9	8° 3' 52".2	8° 6' 45".4	8° 9' 29".6	8° 12' 5".0
E	68 57 46.3	69° 55' 14".2	70° 52' 34".7	71° 49' 45".8	72° 46' 49".0
[illegible] E_1	9.9700436	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] E_1	4.4601610	[illegible]	4.4654635	[illegible]	4.4702011
	[illegible]	8° 3' 52".5	8° 6' 45".4	8° 9' 29".8	[illegible]
E_1	68 57 46".4	69 55' 14".5	70° 52' 34".7	71° [illegible]	72° 46' 49".0
E	[illegible]	69° 55' 14.5	70° 52' 34".7	71° [illegible]	72° 46' 49".0
log sin E	[illegible]	[illegible]	9.9753461	9.9777841	[illegible]
log cos E	[illegible]	[illegible]	[illegible]	9.4939411	[illegible]
cos E	[illegible]	[illegible]	[illegible]	[illegible]	+ 0.296037
log [cos E − sin q]	[illegible]	[illegible]	[illegible]	9.2094721	9.1645781
log r sin j	[illegible]	[illegible]	[illegible]	0.3145403	0.3171349
[illegible]	[illegible]	9.9907745	[illegible]	9.9936376	[illegible]
[illegible]	[illegible]	9.6285708	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0.7206134	0.7633796	[illegible]
J	[illegible] 13' 56".[illegible]	78° 13' 55".2	79° 13' 36".2	80° [illegible]	81° 12' 4".8
[illegible]	[illegible]	0.3190484	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	156° [illegible] 50.1	[illegible]	[illegible]	159° 6' [illegible]
[illegible]	139° 36' 5".1	140° 36' 4".0	141° 35' 45".0	142° [illegible]	143° 34' [illegible]
B + [illegible]	48 38 41.8	49 38' 40.7	50 38 21.7	51 [illegible]	52 36 [illegible]
C + [illegible]	[illegible]	55 54 14.3	56 58 55.3	[illegible]	[illegible]

[illegible]	Jan 2.5	Jan 5.5	Jan 8.5	Jan 11.5	Jan 14.5
[illegible] a	[illegible]	0.3187062	[illegible]	0.3208625	[illegible]
log sin (A+u)	9.8116428	[illegible]	9.7932348	9.7835999	[illegible]
log x	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
x	+ 1.346709	+ 1.322164	+ 1.297232	[illegible]	+ 1.246246
X	+ 0.206202	+ 0.257203	+ 0.307495	[illegible]	+ 0.405370
x+X	+ 1.552911	+ 1.579367	+ 1.604727	+ 1.628859	+ 1.651625
log r sin b	[illegible]	0.2837091	0.2847839	0.2858614	0.2869397
log sin (B+u)	[illegible]	[illegible]	9.8882746	[illegible]	9.9001282
log δ	0.1580575	0.1656866	[illegible]	[illegible]	0.1870670
y	+ 1.438989	+ 1.464400	+ 1.489562	+ 1.514199	+ 1.538245
Y	− 0.881920	− 0.870627	− 0.856892	− 0.840748	− 0.822237
y+Y	+ 0.557069	+ 0.593863	+ 0.632669	+ 0.673450	+ 0.716158
log r sin c	[illegible]	9.9096454	[illegible]	[illegible]	9.9128780
log sin (C+u)	9.9132987	9.9185093	[illegible]	9.9282870	9.9328680
log z	9.8218689	9.8281547	[illegible]	[illegible]	9.8457460
z	+ 0.663543	+ [illegible]	+ [illegible]	+ [illegible]	+ 0.701045
Z	− 0.382621	− 0.377720	− [illegible]	− [illegible]	− 0.356720
z+Z	+ 0.280921	+ 0.295406	+ 0.310901	+ [illegible]	+ [illegible]

[illegible]	Jan. 2.5	Jan 5.5	Jan 8.5	Jan 11.5	Jan 14.5
log(y + Y)	9.7459090	9.7736867	9.8011769	9.8283057	9.8550089
log(x + X)	0.1911466	0.1984830	0.2054015	0.2118835	0.2179116
log tan α	9.5547624	9.5752037	9.5957754	9.6164222	9.6370972
(arc) α	19° 44′ 3″.2	20° 36′ 25″.0	21° 31′ 1″.2	22° 27′ 45″.4	23° 26′ 31″.0
(time) α	1h 18m 56s.21	1h 22m 25s.67	1h 26m 4s.08	1h 29m 51s.03	1h 33m 46s.07
log(z + Z)	9.4485850	9.4705516	9.4926640	9.5148279	9.5369572
log(x + X)	0.1911466	0.1984830	0.2054015	0.2118835	0.2179116
[illegible]	9.2574384	9.2720686	9.2872625	9.3029444	9.3190456
cos α	9.9737138	9.9712836	9.9686271	9.9657324	9.9625889
[illegible]	9.2311522	9.2433522	9.2558896	9.2686768	9.2816345
δ	9° 39′ 48″.2	9° 55′ 59″.8	10° 13′ 5″.4	10° 31′ 0″.5	10° 49′ 40″.4
log(z + Z)	9.4485850	9.4705516	9.4926640	9.5148279	[illegible]
log sin δ	9.2249459	9.2367925	9.2489458	9.2613193	[illegible]
[illegible]	[illegible]	[illegible]	0.2437182	0.2535086	[illegible]
log Abb t	7.9841	7.9943	8.0042	8.0140	[illegible]
Abb t	0.0096	0.0098	0.0101	0.0103	[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
λ_1	75° 29' 10".1	69° 43' 16".0	70° 37' 42".9	71° 2' 9".9	72° 26' 36".8
E_0	73 43 43.0	78° 7' 49".0	79 4 3.0	80° 0' 0".0	80° 55' 57".0
[illegible] E_0	9.9822465	9.9906132	9.9920457	[illegible]	[illegible]
[illegible] E_0	4.4723639	4.4807306	4.4821631	4.4834689	4.4846560
	8° 14' 33".2	8° 24' 10".4	8° 25' 50".3	8° [illegible]	8° 28' 45".0
E	73° 43' 43".3	78° 7' 26".4	79° 3' 33".2	[illegible]	80° 55' 21".8
[illegible] E_1	9.9822467	9.9906031	[illegible]	9.9933409	[illegible]
[illegible] E_1	4.4723641	4.4807205	4.4821510	[illegible]	[illegible]
	8° 14' 33".2	8° 24' 9".7	8° 25' 49".5	8° [illegible]	8° 28' 44".2
E_1	73° 43' 43".3	78° 7' 25".7	79° 3' 72.4	[illegible]	80° 55' 21".0
E	73° 43' 43".3	78° 7' 25.6	[illegible]	[illegible]	[illegible]
[illegible] E	[illegible]	9.9906023	[illegible]	9.9933406	[illegible]
[illegible] E	[illegible]	9.3134413	[illegible]	[illegible]	[illegible]
[illegible] E	+ 0.280186	+ 0.205798	+ 0.189798	+ 0.173787	+ 0.157770
[illegible]	9.1150211	8.7476914	8.6013591	[illegible]	7.8980667
[illegible]	0.3193029	[illegible]	0.3290894	0.3303968	[illegible]
[illegible]	[illegible]	9.9992755	[illegible]	9.9998689	[illegible]
[illegible]	9.4570097	9.0896800	8.9433477	[illegible]	8.2400553
[illegible]	[illegible]	1.2379790	[illegible]	1.6095654	[illegible]
ζ	82° 10' 53".5	86° 41' 28".6	[illegible]	88° 35' 32".8	89° 32' 9".3
[illegible]	[illegible]	0.3283835	[illegible]	[illegible]	0.3315069
[illegible]	160° 5' 28".4	164° 36' 23".5	[illegible]	166° [illegible]	167° 27' 4".2
[illegible] + u	144° 33' 2".3	149° 3' 37".4	150° 0' 48".0	150° 57' 41".6	151° 54' 15".1
β + u	53° [illegible]	58° 6' 14".1	59° 3' 24".7	60° 0' 18".3	60° 56' 54".2
ζ + u	59° 56' 12".6	64° 26' 47".7	65° 23' 58".3	66° 20' 51".9	67° 17' 28".4

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
log r sin a	[illegible]	0.2280413	0.3291144	0.3301857	[illegible]
log sin (A+u)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
log x	[illegible]	0.0391179	0.0279093	[illegible]	[illegible]
[illegible]	+ 1.220203	+ 1.094253	+ 1.[illegible]	[illegible]	+ 1.009753
X	+ 0.452679	+ 0.654552	+ 0.603062	[illegible]	[illegible]
[illegible] + X	+ 1.672582	+ 1.748805	+ 1.759435	[illegible]	[illegible]
log r sin b	0.2880177	[illegible]	0.2941153	[illegible]	0.2962556
log sin (B+u)	9.9057060	9.9289119	9.9333243	[illegible]	9.9416029
log x	[illegible]	0.2219539	0.2274396	[illegible]	[illegible]
[illegible]	+ 1.562153	+ 1.667071	+ 1.188261	[illegible]	+ 1.729253
Y	− 0.801416	− 0.[illegible]	− 0.643[illegible]	− 0.609032	− 0.573029
[illegible] + Y	+ 0.760737	+ 0.991230	+ 1.044[illegible]	+ 1.099957	+ 1.156224
[illegible]	9.9139560	9.9189805	[illegible]	9.9211249	[illegible]
log sin (C+u)	[illegible]	[illegible]	9.9556751	9.9618041	[illegible]
log z	9.8512099	[illegible]	9.8787287	9.8830100	[illegible]
z	+ 0.709921	+ 0.748644	+ 0.756360	+ 0.763569	[illegible]
Z	[illegible]	− 0.293213	− 0.279109	− 0.264227	[illegible]
[illegible] + Z	+ 0.362223	+ 0.455431	+ 0.477251	+ 0.499641	[illegible]

log (y + Y)	[illegible]	[illegible]	[illegible]	[illegible]	0.0630420
log (1 + X)	[illegible]	[illegible]	[illegible]	0.2494400	[illegible]
log tan α	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(arc) α	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
α	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
log (z − Z)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
log (1 − X)	[illegible]	[illegible]	[illegible]	0.2494400	[illegible]
−	[illegible]	[illegible]	[illegible]	9.4512005	[illegible]
log α	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
log [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
c'	11° 0' [illegible]	[illegible]	[illegible]	13° 29' 38"2	[illegible]
log (z + Z)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
log [illegible]	[illegible]	[illegible]	[illegible]	9.3619940	[illegible]
log 1	[illegible]	[illegible]	[illegible]	0.2306643	[illegible]
log [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	+1.74[illegible]053	+1.76[illegible]383
E_0	81 51 [illegible]	[illegible] 42 20.0	Y	−0.535425	[illegible]
[illegible] E_0	[illegible]	9.9964708	y + Y	[illegible]	+1.272046
[illegible] E_0	4.4857221	[illegible]			
	[illegible]	8° 31′ 1″.1	[illegible]	[illegible]	[illegible]
E	81° [illegible]	82° 46′ 31″.9	log sin (C + u)	[illegible]	9.9700285
[illegible] E	9.9955927	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] E	[illegible]	4.4866558	[illegible]	[illegible]	+0.785150
	8° 29′ 59″.2	8° 31′ 5″.9	Z	−0.232297	[illegible]
E	[illegible]	[illegible]	[illegible] − Z	+0.545907	+0.569811
E	[illegible]	82° 46′ [illegible]			
			[illegible] + Y	[illegible]	0.1045028
[illegible] E	[illegible]	9.9965397	[illegible] + X)	0.2498633	0.2501691
[illegible] E	[illegible]	9.0994507	[illegible] α	[illegible]	9.8543337
log [cos E − sin φ]	7.9091279$_n$	33.825564$_n$	[illegible] α	34° 19′ 15″.1	[illegible]
log r sin f	0.3326486	0.3335959	[illegible] α	2^h 1^m 17^s.01	2^h 22^m 15^s.96
sin or cos	9.9999851	[illegible]			
[illegible] f	8.2511115$_n$	[illegible]	[illegible] − Z	[illegible]	9.7557309
log tan f	[illegible]	[illegible]	[illegible] + X)	0.2498633	[illegible]
f	90° 28′ 29″.6	91° 24′ 33″.3	[illegible]	[illegible]	9.5055618
[illegible]	0.3326635	0.3337273	[illegible] α	9.9169238	[illegible]
u	168° 23′ 24″.5	[illegible]	[illegible]	[illegible]	9.4158875
[illegible]	152° 50′ 38″.4	153° 46′ 42″.1	δ	14° 13′ 57″.6	14° 36′ 13″.0
B − u	61° 53′ 15″.1	62° 49′ 18″.8			
C + u	68° 13′ 48″.7	[illegible]			
[illegible]	0.3323213	[illegible]			
[illegible]	9.6593597	9.6452696			
[illegible]	9.9916810	9.9786547	[illegible] − Z	9.7371668	[illegible]
[illegible]	+0.981027	+0.952030	[illegible]	9.3906879	[illegible]
x	+0.796692	[illegible]	log Δ	0.3464789	[illegible]
− Y	+1.777719	+1.778972	log abbr	8.1070	[illegible]
log r sin b	0.2973222	[illegible]	abbr b	−0′.0128	[illegible]
[illegible] (B + u)	9.9454806	9.9491903			
log y	0.242802	0.2475763			

Since the [illegible] to the ecliptic and mean equinox for the beginning of the year from which we have derived the Ephemeris, the places of the planet just found are thus referred to the same equinox, also we have used the mean obliquity of the ecliptic for the adopted date of the fixed equinox, both in the computations of our auxiliary constants and [illegible] reductions.

A further reduction must be made in order to reduce these places to the true equinox of the [illegible] date. The formulæ for [illegible] and nutation are as follows:

$$\Delta\alpha = f + g\sin(G+\alpha)\tan\delta$$

$$\Delta\delta = g\cos(G+\alpha).$$

Then

$$\text{true } \alpha = \alpha + \Delta\alpha$$

$$\text{true } \delta = \delta + \Delta\delta.$$

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G. M. T.	Oct. 8.5	Oct. 12.5	Oct. 16.5	Oct. 20.5	Oct. 24.5
δ	12° 26.'8	11° 59.'0	11° 30.'2	11° 1.'1	10° 32.'5
α	19 17.1	18 19.4	17 22.5	16 28.0	15 37.2
G	30 44.0	30 28.0	30 13.0	29 59.0	29 47.0
G + α	50 1.1	47 35.5	47 35.5	46 27.0	45 24.2
sin (G + α)	1.88437	1.87639	9.86337	9.86020	9.85252
g	1.07900	1.08380	1.08890	1.09430	1.10000
cos (G + α)	9.80790	9.81876	9.82892	9.83821	9.84640
g sin (G + α)	0.96373	0.96019	0.95717	0.95450	0.95252
tan δ	9.34384	9.32685	9.36859	9.28940	9.26971
f	+ 23.''69	+ 24.''03	+ 24.''37	+ 24.''73	+ 25.''11
g sin (G + α) tan δ	+ 2.03	+ 1.93	+ 1.84	+ 1.75	+ 1.67
(sec) Δα	+ 2.'72	+ 2.'96	+ 2.'21	+ 2.'48	+ 2.'78
(time) Δα	+ 1.'71	+ 1.'72	+ 1.'74	+ 1.'76	+ 1.'78
Δδ	+ 7.''71	+ 7.''99	+ 8.28	+ 8.56	+ 8.84

G. M. T.	Oct. 28.5	Nov. 1.5	Nov. 5.5	Nov. 9.5	Nov. 13.5
δ	10° 5.'1	9° 24.'6	9° 16.'[illegible]	8° 56.'[illegible]	8° 39.'2
α	14° 51.'6	14 12.2	13 39.8	13 14.9	12 58.0
G	29 34.0	29. 80	29 8.0	28 55.0	28 40.0
G + α	44 25.[illegible]	42 47.[illegible]	42 [illegible]	42 1.[illegible]	41 38.[illegible]
sin (G + α)	9.84510	9.83212	9.83212	9.82690	9.82240
g	1.10590	1.11860	1.11860	1.12520	1.13200
cos (G + α)	9.85379	9.86556	9.86556	9.86994	9.87356
g sin (G + α)	0.95100	0.95072	0.95072	0.95210	0.95440
tan δ	9.25007	9.21301	9.21301	9.19698	9.17380
f	+ 25.''51	+ 26.''37	+ 26.''37	+ 26.''84	+ 27.''33
g sin (G + α) tan δ	+ 1.60	+ 1.46	+ 1.46	+ 1.41	+ 1.34
Δα	+ 27.''11	+ 27.''83	+ 27.''83	+ 28.''25	+ 28.''67
Δα	+ 1.'81	+ 1.'85	+ 1.'85	+ 1.'88	+ 1.'91
Δδ	+ 9.''11	+ 9.''64	+ 9.''64	+ 9.''89	+ 10.''13

G. M. T.	[illegible]	Nov. 21.5	[illegible]	Nov 29.5	Dec. [illegible]
δ	8° 2.6	8° 1[illegible].4	8° [illegible]	8° 5.9	8° 6.2
α	12 49.3	12 48.8	12 [illegible]6.4	13 11.8	13 34.6
G	28 24.0	28 [illegible]7.0	27 [illegible]	[illegible]	27 [illegible]
G + α	[illegible]	40 [illegible]	[illegible]	40 38.8	40 39.6
sin (G + α)	9.81887	9.81[illegible]3	9.81467	9.[illegible]4	9.81[illegible]6
g	1.13900	1.14600	1.[illegible]	1.16030	1.16740
cos (G + α)	9.87632	9.87824	9.87[illegible]	9.88009	9.88000
g sin (G + α)	0.95737	0.96233	0.96737	0.97414	0.98136
tan δ	9.17068	9.16171	9.1[illegible]	9.1[illegible]	9.1[illegible]45
+ +	27.84	+ 28.37	+ 28.9[illegible]	+ 29.50	+ 30.09
g sin (G+α) tan δ	+ 1.34	+ 1.33	+ 1.[illegible]	+ 1.34	+ 1.36
Δα″	+ 29.18	+ [illegible]	+ [illegible]76	+ 30.84	+ 31.45
Δα^s	+ 1.[illegible]4	+ 1.98	+ 2.0[illegible]	+ 2.05	+ 2.09
Δδ	+ 10.36	[illegible]	+ 10.7[illegible]	+ 10.97	+ 11.15

G. M. T.	Dec. 7.5	[illegible]	[illegible]	Dec 19.5
δ	8° 9.8	[illegible] 16.4	8° 26.0	[illegible] 38.3
α	14 4.4	[illegible]	5 23.6	16 12.[illegible]
G	26 40.0	26 1[illegible].0	2[illegible] 47.[illegible]	2[illegible] 1[illegible].0
G + α	40 44.4	40 [illegible]	4[illegible] 1[illegible]	41 [illegible]
sin (G + α)	9.81467	9.81633	9.81840	9.82131
g	1.17450	1.18150	1.18840	1.19510
cos (G + α)	9.87[illegible]	9.87824	9.87661	9.87442
g sin (G + α)	0.98917	0.99[illegible]	1.00688	1.01641
tan δ	9.15670	9.16[illegible]	9.17103	9.18161
f	+ 30.69	+ 31.31	+ 31.93	+ 32.56
g sin (G+α) tan δ	+ 1.44	+ 1.4[illegible]	+ 1.51	+ 1.[illegible]6
Δα″	+ 32.09	+ [illegible]76	+ 33.44	+ 34.12
Δα^s	+ 2.14	+ [illegible]	+ 2.23	+ 2.27
Δδ	+ 11.32	[illegible]	+ 11.61	+ 11.74

Determining now the quantities $\Delta\alpha$ and $\Delta\delta$, the corrections to be made for precession for the respective dates for which we have computed the co-ordinates, with α and δ, the next step requires that from the true positions thus obtained we interpolate in order to find the intermediate places for each day.

For making the interpolation to fourths we use the formula

$$u_t = u_0 + t\,\Delta'_{\frac{1}{2}} + \frac{t(t-1)}{2}\,\Delta''_{\frac{1}{2}} + \frac{t(t-1)(t-\frac{1}{2})}{1\cdot 2\cdot 3}\,\Delta'''_{\frac{1}{2}} + \cdots$$

Putting

$$\Delta_1 = \frac{1}{4}\left[\Delta'_{i+\frac{1}{2}} \mp \frac{1}{4}\Delta''_{i+\frac{1}{2}}\right]$$

$$\Delta_2 = \frac{1}{32}\left[\Delta''_i \mp \frac{1}{3}\Delta'''_i\right]$$

Then the computations can be recorded in

[illegible]

[illegible]

upon the accuracy of the work, and for convenience to use in reducing these places to agree with the respective dates of the observations themselves for the purpose of deriving the residuals, which give us the difference between the computed and the [illegible]

(vide next page)

	α						Δ_1	Δ_2	Δ'	Δ''	Δ'''
[illegible]	1	[illegible]	[illegible]	–	[illegible]						
[illegible]	1	[illegible]	[illegible]	– 0	[illegible]				– 3 [illegible]	– [illegible]	
[illegible]	1	[illegible]	[illegible]	– 0	[illegible]		[– 0 [illegible]]	= [0.011]			
[illegible]	1	[illegible]	[illegible]	– 0	[illegible]					– [illegible]	+ [illegible]
[illegible]	1	12	[illegible]	– 0	[illegible]		[– 0 [illegible]]	= [illegible]			
[illegible]	1	11	[illegible]	– 0	[illegible]				– 3 [illegible]	– [illegible]	– [illegible]
[illegible]	1	10	[illegible]	– 0	[illegible]		[– 0 56.52]	= [illegible]			
[illegible]	1	[illegible]	[illegible]	– 0	[illegible]					– [illegible]	– [illegible]
[illegible]	1	[illegible]	[illegible]	– 0	[illegible]		[– 0 [illegible]]	= [illegible]			
[illegible]	1	[illegible]	[illegible]	– 0	54.25				– 3 [illegible]	– [illegible]	– [illegible]
[illegible]	1	6	[illegible]	– 0	[illegible]		[– 0 [illegible]]	= [illegible]			
[illegible]	1	[illegible]	[illegible]	– 0	[illegible]					– [illegible]	+ [illegible]
[illegible]	1	5	[illegible]	– 0	[illegible]		[– 0 [illegible]]	= [illegible]			
[illegible]	1	[illegible]	[illegible]	– 0	[illegible]				– [illegible]	– [illegible]	– [illegible]
[illegible]	1	[illegible]	[illegible]	– 0	[illegible]		[– 0 [illegible]]	= [illegible]			
[illegible]	1	[illegible]	[illegible]	– 0	[illegible]					– [illegible]	+ [illegible]
[illegible]	1	[illegible]	[illegible]	– 0	[illegible]		[– 0 47.01]	= [illegible]			
[illegible]	1	[illegible]	[illegible]	– 0	[illegible]				– 3 [illegible]	– [illegible]	– [illegible]
[illegible]	1	[illegible]	[illegible]	– 0	[illegible]		[– 0 [illegible]]	= [illegible]			
[illegible]	0	59	[illegible]	– 0	[illegible]					– [illegible]	+ [illegible]
[illegible]	0	[illegible]	[illegible]	– 0	[illegible]		[– 0 41.06]	= [illegible]			
[illegible]	0	[illegible]	[illegible]	– 0	[illegible]				– [illegible]	– [illegible]	– [illegible]
[illegible]	0	[illegible]	[illegible]	– 0	[illegible]		[– 0 37.76]	= [illegible]			
[illegible]	0	[illegible]	[illegible]	– 0	[illegible]					– [illegible]	– [illegible]
[illegible]	0	[illegible]	[illegible]	– 0	[illegible]		[– 0 [illegible]]	= [illegible]			
[illegible]	0	[illegible]	[illegible]	– 0	[illegible]				– [illegible] 4.66	– [illegible]	– [illegible]
[illegible]	0	[illegible]	[illegible]	– 0	[illegible]		[– 0 [illegible]]	= [illegible]			
[illegible]	0	[illegible]	[illegible]	– 0	[illegible]					– [illegible]	– [illegible]
[illegible]	0	[illegible]	[illegible]	– 0	[illegible]		[– 0 [illegible]]	= [illegible]			
[illegible]	0	[illegible]	[illegible]	– 0	[illegible]				– 1 [illegible]	– [illegible]	– 1.03
[illegible]	0	[illegible]	[illegible]	– 0	[illegible]		[– 0 [illegible]]	= [illegible]			
[illegible]	0	[illegible]	1.56	– 0	[illegible]					– [illegible]	+ [illegible]
[illegible]	0	[illegible]	[illegible]	– 0	[illegible]		[– 0 [illegible]]	= [illegible]			

Nov.	11.5	0	52	23.72	−	15.80			−	1	7.58	+[23.33]	+ 0.80
	12.5	0	52	7.83	−	12.85	[− 0 14.87] ∓	[1.02]				+32.57	+ [0.54]
	13.5	0	51	53.98	−	11.79							
	14.5	0	51	42.19	−	9.73	[− 0 10.76] ∓	[1.03]	−	0	34.81	+[32.87]	+ 0.19
	15.5	0	51	32.46	−	7.68						+32.96	− [0.26]
	16.5	0	51	24.78	−	5.61	[− 0 6.65] ∓	[1.03]					
	17.5	0	51	19.17	−	3.53			−	0	1.85	+[32.61]	− 0.71
	18.5	0	51	15.64	−	1.47	[− 0 2.50] ∓	[1.03]					
	19.5	0	51	14.17	−	0.56						+32.85	− [0.91]
	20.5	0	51	14.73	−	2.59	[+ 0 1.57] ∓	[1.01]	−	0	30.41	+[31.70]	− 1.11
	21.5	0	51	17.32	+	4.62							
	22.5	0	51	21.94	+	6.62	[+ 0 5.62] ∓	[1.00]				+ 31.14	− [1.32]
	23.5	0	51	28.56	+	8.60							
	24.5	0	51	37.16	+	10.56	[+ 0 9.58] ∓	[0.98]	+	1	1.[illegible]	+[30.37]	− 1.54
	25.5	0	51	47.73	+	12.53							
	26.5	0	52	00.26	+	14.45	[+ 0 13.40] ∓	[0.96]				+ 29.60	− [1.52]
	[illegible]	0	52	14.71	+	16.32							
	28.5	0	52	31.05	+	18.22	[+ 0 17.28] ∓	[0.94]	+	1	31.14	+[28.50]	− 1.49
	[illegible]	0	52	49.26	+	20.07							
	[illegible]	0	53	9.33	+	21.89	[+ 0 20.98] ∓	[0.95]				+ 28.11	− [1.47]
Dec.	1.5	0	53	31.22	+	23.70							
	2.5	0	53	54.92	+	25.48	[+ 0 24.59] ∓	[0.89]	+	1	30.25	+[27.30]	− 1.45
	3.5	0	54	20.40	+	27.23							
	4.5	0	54	47.63	+	28.97	[+ 0 28.10] ∓	[0.87]				+ 26.66	− [1.46]
	5.5	0	55	16.60	+	30.68							
	6.5	0	55	47.29	+	32.37	[+ 0 31.52] ∓	[0.84]	+	2	25.91	+[25.93]	− 1.47
	7.5	0	56	19.65	+	34.04							
	8.5	0	56	53.70	+	35.68	[+ 0 34.86] ∓	[0.82]				+ 25.19	− [1.50]
	9.5	0	57	29.38	+	37.30							
	10.5	0	58	6.68	+	38.89	[+ 0 38.10] ∓	[0.80]	+	2	51.10	+[24.42]	− 1.54
	11.5	0	59	45.55	+	40.47							
	12.5	0	59	26.02	+	42.03	[+ 0 41.25] ∓	[0.78]				+ 23.65	− [1.56]
	13.5	1	0	8.05	+	43.55							
	14.5	1	0	51.60	+	45.05	[+ 0 44.30] ∓	[0.75]					
	15.5	1	1	36.66	+	46.55							
	16.5	1	4	51.42				[0.72]	+	3	14.75		

1887 Oct	9.5	12°	26'	25.5	-	6	59.2	-[6'	50.5]						
	10.5	12	13	14.7	-	7	4.0				-	27'	44.4	- [88.7]	
	11.5	12	6	15.5	-	7	8.1	-[7	1.6]	± [2.4]					
	12.5	11	59	11.4	-	7	11.5							- 65.0	+ [47.4]
	13.5	11	52	3.3	-	7	14.0	-[7	9.5]	± [-1.7]					
	14.5	11	44	51.8	-	7	15.8				-	28	49.4	- [41.2]	- 47.5
	15.5	11	37	37.8	-	7	16.9	-[7	14.9]	± [0.9]					
	16.5	11	30	22.0	-	7	17.3							- [17.5]	+ [47.6]
	17.5	11	23	5.1	-	7	16.9	-[7	17.1]	± [0.2]					
	18.5	11	15	47.8	-	7	15.8				-	29	6.9	+ [6.3]	+ 47.7
	19.5	11	8	30.9	-	7	13.7	-[7	16.3]	± [0.6]					
	20.5	11	1	15.1	-	7	11.1							+ 30.2	- [46.1]
	21.5	10	54	1.3	-	7	9.9	-[7	12.4]	± [1.3]					
	22.5	10	46	50.2	-	7	3.9				-	28	36.7	+ [52.5]	+ 44.6
	23.5	10	39	42.3	-	6	59.0	-[7	5.9]	± [2.0]					
	24.5	10	32	38.4	-	6	53.6							+ 74.8	- [41.5]
	25.5	10	25	39.3	-	6	47.9	-[6	56.3]	± [2.7]					
	26.5	10	18	45.7	-	6	41.3				-	27	21.9	+ [94.0]	+ 38.4
	27.5	10	11	57.8	-	6	34.0	-[6	44.6]	± [3.3]					
	28.5	10	5	16.5	-	6	26.5							+ 113.2	+ [34.7]
	29.5	9	58	42.5	-	6	18.4	-[6	30.2]	± [3.8]					
	30.5	9	52	16.0	-	6	9.8				-	25	28.7	+ [128.7]	+ 31.0
	31.5	9	45	57.6	-	6	0.6	-[6	14.1]	± [4.3]					
Nov.	1.5	9	39	47.8	-	5	51.2							+ 14.42	- [28.5]
	2.5	9	33	47.1	-	5	41.4	-[5	55.9]	± [4.7]					
	3.5	9	27	55.9	-	5	31.2				-	23	4.5	+ [15.72]	- 26.0
	4.5	9	22	14.5	-	5	20.3	-[5	36.3]	± [5.1]					
	5.5	9	16	43.3	-	5	9.4							+ 170.3	+ [22.9]
	6.5	9	11	23.0	-	4	58.1	-[5	14.8]	± [5.5]					
	7.5	9	6	13.6	-	4	46.5	-			-	20	14.3	- [180.1]	- 19.8
	8.5	9	1	15.5	-	4	34.5	-[4	52.3]	± [5.8]					
	9.5	9	56	29.0	-	4	22.3							+ 190.0	- [6.9]
	10.5	8	51	54.5	-	4	10.0	-[4	28.4]	± [6.1]					
	11.5	8	47	32.2	-	3	57.4				-	17	4.3	+ [197.0]	- 14.1
	12.5	8	43	22.1	-			-[4	3.7]	± [6.3]					

[illegible]		32 [illegible]	− 3 [illegible]				+ 264.1	[11 2]
[illegible]		[illegible] 4.1	− 3 21.0	[− 3 38.0]	∓ [0 5]			
[illegible]		32 8.0	− 3 15.6			− 13 40.2	− [265 2]	+ 5 4
[illegible]		25 40.0	− 3 5.4	[− 3 12.0]	∓ [0 6]			
[illegible]		25 44.5	− 2 51.0				− [221.6]	+ [5.1]
[illegible]		[illegible]	− 2 [illegible]	[− 2 40.0]	∓ [0 7]			
[illegible]		20 14.0	− 2 28 3			− 10 7.7	− [213.4]	+ 1 5
[illegible] 5		17 [illegible]	− 2 11.0	[− 2 18.6]	∓ [0 7]			
[illegible]		[illegible]	− 1 55.3				− 214.3	− [illegible]
[illegible]		13 28 [illegible]	− 1 44.0	[− 1 51.6]	∓ [0 7]			
[illegible]		11 52 6	− 1 31.7			− 6 [illegible]	− [212 5]	− 6
[illegible]		10 21.0	− 1 18 8	[− 1 28.1]	∓ [0 6]			
[illegible] 6		9 3 [illegible]	− 1 5.1				− 210.7	− [5.4]
[illegible]		[illegible]	− 0 52.2	[− 0 58.0]	∓ [0 5]			
[illegible]		[illegible] 6 1	− 0 39.1			− [illegible]	− [207.1]	− [illegible]
[illegible]		6 27.0	− 0 26 3	[− 0 32.7]	∓ [0 4]			
[illegible]		6 [illegible]	− 0 13 5				− 202 5	− [7.1]
[illegible]		5 47.2	− 0 [illegible]	[− 0 7.2]	∓ [0 3]			
[illegible]		5 4[illegible]	− 0 11.5			− 0 20.8	+ [198.0]	− 4.1
[illegible]		5 57.5	+ 0 23 7	[+ 0 17.6]	∓ [0 1]			
[illegible]		6 21.5	+ 0 36 0				+ 194.4	− [4.4]
[illegible]		6 57.5	+ 0 48.0	[+ 0 42.0]	∓ [0 0]			
[illegible]		7 45.5	+ 0 59.7			− 3 35.8	+ [189.0]	− 4.7
[illegible]		8 45.3	+ 1 11.4	[+ 1 5.6]	∓ [illegible]			
[illegible]		9 56.7	+ 1 23.0				+ 184 7	− [illegible]
[illegible]		11 [illegible]	+ 1 34 4	[+ 1 28.7]	∓ [illegible]			
[illegible]		12 34.2	+ 1 45 [illegible]			− 6 34.4	+ [179.7]	− 10 6
[illegible]		14 3[illegible]	+ 1 56.7	[+ 1 51.2]	∓ [illegible]			
[illegible]		16 16.6	+ 2 7.6				+ 174.1	− [10.7]
[illegible]		18 44.2	+ 2 18 4	[+ 2 13.0]	∓ [5.4]			
[illegible]		21 2.0	+ 2 28.8			− 9 24.0	+ [168.7]	− 11 2
[illegible]		22 31.4	+ 2 39.2	[+ 2 34.0]	∓ [5 2]			
[illegible]		26 10.6	+ 2 49.4				+ 162.7	− [11.4]
[illegible]		2[illegible]	+ 2 59.4	[+ 2 54.4]	∓ [5.0]			
[illegible]		31 [illegible]	+ 3			− 12 16.9	+ [157.[illegible]]	
[illegible]				[+ 3 [illegible]]				
[illegible]		3[illegible] [illegible]						

	α				δ			
[illegible]	1h	15m	14[illegible]		+12	1′	14.7″	
				-7.61 (+.01)	+12	1′	14.7″	-41[illegible] (-.24)
11.5	1	14	16.31	-7.47 (+.01)	+12	6	1[illegible]	421.6 (-.24)
12.0				-57.47				424.0
12.5	1	13	19.42	-57.40	+11	57	11.4	426.1
13.0				-57.[illegible] (+.12)				428.1
13.5	1	12	22.07	-57.23 (+.12)	+11	[illegible]	[illegible]	-4[illegible]
14.0				-57.11 (+.17)				4[illegible]
14.5	1	11	24.96	-5[illegible]	+11	44	[illegible]	-4[illegible]
15.0				-56.7[illegible] (+.23)				434[illegible]
15.5	1	10	25.21	-56.52 (+.2)	+11	37	37.[illegible]	-4[illegible]
16.0				-56.27				4[illegible]
16.5		9	1.9[illegible]	-[illegible]	+11	30	22.[illegible]	-4[illegible]
17.0				-5[illegible]				4[illegible]
17.5		8	[illegible]	[illegible]	+11	23	[illegible]	-4[illegible]
18.0				[illegible]				4[illegible]
18.5		7	41.3[illegible]	-54.6[illegible]	+11	15	47.[illegible]	4[illegible]
19.0				-54.2[illegible]				-4[illegible]
19.5		6	46.98	-53.83	+11	[illegible]	[illegible]	4[illegible]
20.0				-[illegible]				-4[illegible]
20.5		5	53.58	-52.89	+11	1	1[illegible]	-4[illegible]
21.0				-52.[illegible]				4[illegible]
21.5		5	1.19	-[illegible]	+10	54	13	-4[illegible]
22.0				-[illegible]				-4[illegible]
22.5		4	[illegible]	-50.[illegible]	+10	46	[illegible]	-4[illegible]
23.0				-50.2[illegible]				4[illegible]
23.5		[illegible]	19.61	-49.62 (+61)	+10	[illegible]	42.3	-4[illegible]
24.0				-49.01 (+66)				-4[illegible]
24.5		2	30.60	-48.35 (+66)	+10	[illegible]	[illegible]	4[illegible]
25.0				-47.69				419
25.5		1	42.91	-47.01	+10	[illegible]	[illegible]	-41[illegible]
26.0				-46.33 (+71)				413[illegible]
26.5		0	[illegible]	-4[illegible] (+71)	+10	1[illegible]	4[illegible].7	410[illegible]
27.0				-44.[illegible]				407[illegible]
27.5		0	11.67	-44.17 (+74)	+10	11	[illegible]	4[illegible]
[illegible]				4[illegible]				4[illegible]
[illegible].0		59	23.24	-42.6[illegible] (+77)	+10	[illegible]	[illegible]	[illegible]

Mi.	29.0			−41.85					[illegible]
	29.5	[illegible]	[illegible]	46.39 −41.06	+79	+ 9	[illegible]	42.5	[illegible]
	30.0			−40.27					[illegible]
	30.5		[illegible]	6.11 [illegible]	+82	+ 9	[illegible]	[illegible]	[illegible]
	31.0			−38.63	+82				[illegible]
	31.5		57	27.49 −7.76	+87	+ 9	[illegible]	[illegible]	[illegible]
N.O.	1.0			6.90					[illegible]
	1.5		56	50.68 −36.00	+89	+ 9	[illegible]	[illegible]	[illegible]
	2.0			−35.11					[illegible]
	2.5		56	1[illegible].47 −34.21	+90	+ 9	[illegible]	47.1	[illegible]
	3.0			−33.31					[illegible]
	3.5		55	42.16 −32.40	+91	+ 9	[illegible]	[illegible]	[illegible]
	4.0			−31.50					[illegible]
	4.5		55	10.66 −30.57	+93	+ 9	[illegible]	14.5	[illegible]
	5.0			−29.64	+93				[illegible]
	5.5		54	41.02 −2[illegible]	+94	+ 9	16	[illegible]	[illegible]
	6.0			−27.76					[illegible]
	6.5		54	13.26 −26.80	+96	+ 9	11	[illegible]	[illegible]
	7.0			−25.84	+96				[illegible]
	7.5		53	47.42 [illegible]	+96	+ 9	6	13.6	[illegible]
	8.0			[illegible]					[illegible]
	8.5		53	23.50 −22.93	+99	+ 9	1	[illegible]	−242.5
	9.0			−21.94	+99				−286.5
	9.5		53	1.56 −20.93	+101	+ 8	[illegible]	[illegible]	[illegible]
	10.0			−19.93					[illegible]
	10.5		52	41.63 −18.92	+101	+ 8	[illegible]	[illegible]	[illegible]
	11.0			−17.91	+101				−262.[illegible]
	11.5		52	23.72 −16.90	+101	+ [illegible]	47	[illegible]	[illegible]
	12.0			−15.89	+101				[illegible]
	12.5		52	[illegible] −14.87	+102	+ 8	43	[illegible]	[illegible]
	13.0			[illegible]					−[illegible]
	13.5		51	53.98 −12.82	+103	+ 8	[illegible]	24.7	[illegible]
	14.0			−11.79	+105				[illegible]
	14.5		51	41.19 −10.76		[illegible]	[illegible]	[illegible]	[illegible]
	15.0			−9.73					[illegible]
	15.5		51	32.46 −8.70	+10[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	16.0			−7.68					[illegible]
	16.5		51	24.78 −6.73	+103 +104	+ 8	28	47.9	[illegible]

Aug. 16.5	0h	51m	24s.78		+8°	25′	49.9″
17.0				−5.61			−184.4
17.5		51	19.17	−4.57	+8	25	44.5 − 178.2
18.0							−171.9
18.5		51	[illegible]	[illegible]	+8	21	52.5 − 165.2
19.0				−1.47			
19.5		51	14.17	−0.44	+8	20	14. [illegible]
20.0				+0.56			−145.3
20.5		51	14.73	+1.57	+8	17	48.7 − 138.6
21.0				+2.59			[illegible]
21.5		51	17.32	+3.60	+8	[illegible]	36.8 − 125.1
22.0				+4.62			−118.3
22.5		51	21.94	+5.62	+8	13	38.5 − 111.6
23.0				+6.62			−104.9
23.5		51	28.56	+7.61	+8	11	53.6 − 98.3
24.0				+8.60			[illegible]
24.5		51	37.16	+9.58	+8	10	21.9 − 85.1
25.0				+10.57			[illegible]
25.5		51	47.73	+11.55	+8	9	2.4 − 71.8
26.0				+12.53			[illegible]
26.5		52	00.26	+13.49	+8	7	58.3 − 58.6
27.0				+14.45			[illegible]
[illegible]		52	14.71	[illegible]	[illegible]	7	6.1 − 45.6
28.0				+16.34			[illegible]
[illegible]		[illegible]	[illegible]	+17.27	[illegible]	6	[illegible]
29.0				+18.21			−26.3
29.5		52	49.26	+19.14	+8	6	0.7 −19.7
[illegible]				+20.07			−13.5
[illegible]		53	[illegible]	[illegible]	[illegible]	[illegible]	57.2 −7.2
Sept. 1.0				+22.89			−6.9
1.5		53	31.22	+22.79	+8	[illegible]	46.3 + 5.3
2.0				+23.70			[illegible]
2.5		53	54.42	+24.59	+8	[illegible]	[illegible]
3.0				+25.48			+23.7
3.5		54	20.40	+26.35	+8	6	21.5 [illegible]
4.0				+27.23			[illegible]
4.5		54	47.63	+27.10	+8	[illegible]	[illegible]
				+28.97			[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	42.60	[illegible]	+8°	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]					[illegible]						[illegible]
5.0		[illegible]		10.60	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6.0					[illegible]						[illegible]
6.5		55		42.19	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7.0					[illegible]						[illegible]
7.5		56		19.65	[illegible]	[illegible]	[illegible]	[illegible]	6.7	[illegible]	[illegible]
8.0					+34.[illegible]					[illegible]	
8.5		56		[illegible]	+34.36	[illegible]	[illegible]	[illegible]	19.8	[illegible]	[illegible]
9.0					[illegible]					[illegible]	
9.5		57		[illegible]	[illegible]	[illegible]	[illegible]	12	54.2	+100.0	[illegible]
10.0					+[illegible].30					+105.7	
10.5		58		[illegible]	[illegible]	[illegible]	[illegible]	14	39.9	+111.[illegible]	
11.0					[illegible]					+116.7	
11.5		59		[illegible]	[illegible]	[illegible]	[illegible]	16	36.6	+122.[illegible]	
12.0					+40.47					[illegible]	
12.5		59		[illegible]	141.[illegible]	[illegible]	[illegible]	18	44.[illegible]	[illegible]	
13.0					+42.[illegible]					+158.4	
13.5	1	0		[illegible]	+42.79	[illegible]	[illegible]	21	2.6	[illegible]	[illegible]
14.0					[illegible]					+[illegible]	
14.5		0		[illegible]	[illegible]	[illegible]	[illegible]	23	[illegible]	[illegible]	[illegible]
15.0					[illegible]					[illegible]	
[illegible]		[illegible]		[illegible]				26	10.6		

The co-ordinates for α and δ are computed for every third day after January 1st 1885, and the following for making the interpolation to thirds is used

$$u_t = u_0 + t\,\Delta'_{\frac{1}{2}} + \frac{t(t-1)}{1\cdot 2}\,\Delta''_0 + \frac{t(t^2-1)}{1\cdot 2\cdot 3}\,\Delta'''_{\frac{1}{2}} + \cdots\cdots \text{[illegible]}$$

[illegible] put [illegible]

$$\delta' = \tfrac{1}{2}\left(\Delta'_{\frac{1}{2}} - \tfrac{1}{4}\,\Delta''_0\right)$$

$$\delta'' = \tfrac{1}{4}\,\Delta'_{\frac{1}{2}}$$

1888									
Jan. 2.5	1	1[illegible]	[illegible]		[illegible]	+1.0[illegible]		[illegible]	
				+68.7[illegible]	+68.71				
[illegible]		20	[illegible]	+6[illegible]		+1.0[illegible]			
				+69.[illegible]	+69.[illegible]		3	29.49	[illegible]
4.5		21	14.1[illegible]	+70.[illegible]		+1.01			
				+70.[illegible]	+70.[illegible]				
[illegible]		22	[illegible]	+70.[illegible]	+	+0.97		+8.95	
				+71.8[illegible]	+71.[illegible]				
6.5		23	[illegible]	+72.[illegible]		+0.97			
				+72.0[illegible]	+72.81		3	3[illegible].44	[illegible]
7.5		24	4[illegible].67	+73.[illegible]		+0.96			
				+73.[illegible]	+73.77				
[illegible]		26	3.44	+74.24		+0.95		[illegible]	
				+74.72	+74.72				
9.5		27	18.16	+75.70		+0.94			
				+75.68	+7[illegible].66		3	46.98	[illegible]
10.5		28	33.84	+76.13		+0.92			
				+76.[illegible]	+76.58				
11.5		29	[illegible].42	+77.02		+0.90		+8.[illegible]9	
				+77.47	+77.47				
12.5		31	7[illegible].89	+77.92		+0.[illegible]			
				+7[illegible]	+78.35		3	55.07	[illegible]
13.5		32	26.27	+78.80		+0.[illegible]			
				+7[illegible]	+7[illegible].12				
14.5		33	[illegible].49	+7[illegible].64		+0.[illegible]		+7.7[illegible]	
				+80.[illegible]	+80.[illegible]				
[illegible]		[illegible]	[illegible]	+80.[illegible]		+0.8[illegible]			
				+80.96	+80.93		4	[illegible].80	
16.5		36	26.53	+81.41		[illegible]			
				+81.86	+81.76				
[illegible]		37	48.29			[illegible]			

							Δ'	Δ''	Δ'''
[illegible]	[illegible]	[illegible]	10,30	+91.71 / 92.01	[illegible]	+0,61		[illegible]	
				92,31	+[illegible]				
[illegible]	1.[illegible]	59	42,61	+92.61		+0,60			
				92.91	+[illegible]		+[illegible],74		
"	2,5 2	1	[illegible]	[illegible]		+0,60			−0,18
				+[illegible]	+[illegible]				
"	3.[illegible]	2	47,04	[illegible]		+[illegible]	+2	+5,36	
				94.11	+94.11				
	4.[illegible]	4	[illegible]	94.41		+0,[illegible]			
				+94.70	+94.70		+[illegible]8,10		−0,17
	[illegible]	5	[illegible]	[illegible]		+			
				95,18	+95,18				
	6.[illegible]	7	[illegible]	[illegible]		[illegible]		+5,11	
				+95,86	+[illegible]				
	[illegible]	9	[illegible]	96.15		+0,57			
				96.44	+96.43		+[illegible],29		−0,24
	8.[illegible]	10	[illegible],44	96.71		+[illegible]			
				96.99	+96.99				
	9.[illegible]	12	[illegible]2,43	97.27		+[illegible]		+4,[illegible]	
				97.[illegible]	+97.[illegible]2				
	10.[illegible]	13	[illegible]	97.[illegible]		+[illegible]			
				[illegible]	+[illegible]2		+[illegible]4,24		−0,[illegible]
	11.[illegible]	15	[illegible]	[illegible]		+[illegible]			
				[illegible]	+98.59				
	12.5	17	16,67	98.[illegible]		[illegible]		+4,[illegible]	
				99.12	+[illegible]				
	[illegible]	18	55,77	99.42		+[illegible]			
				99.72	+[illegible]		+[illegible]8,77		
	14.5	21	35,51	99.72		+			
				100,13	+100,13				
	[illegible]	22	15,64						

1888			δ			δ'	δ''			
Jan.	2.5	9°	39'	41.3			+6.5			
					+317.6	5'	17.6			
"	3.5		44	[illegible]	[illegible]		+6.[illegible]			
					+[illegible]4.1	5	23.9	+16	11.[illegible]	−[illegible]
"	4.5		50	23.0	+327.1		+6.2			
					+[illegible]	[illegible]	[illegible]			
"	5.5		55	53.1	+333.0		+6.0		+53.9	
					+336.0	5	36.0			
"	6.5	10	1	29.1	+339.0		+5.9			
					+[illegible]42.1	[illegible]	41.9	+17	[illegible]	4.4
"	[illegible]		7	11.2	+344.8		[illegible]			
					+347.6	[illegible]	47.6			
"	8.5		12	58.8	+350.2		+5.5		+49.5	
					+[illegible]	[illegible]	[illegible]			
	9.5		18	[illegible].7	+[illegible]		+[illegible]			
					+[illegible]8.7	[illegible]	[illegible]	+17	[illegible]	[illegible]
"	10.5		24	[illegible].4	+361.1		[illegible]			
					+363.6	6	3.6			
"	11.5		30	54.0	+366.0		+5.0		+44.[illegible]	
					+368.4	6	8.4			
"	12.5		37	2.4	+371.0		+4.9			
					+37[illegible].7	6	[illegible]	+18	40.1	−4.4
"	13.5		43	16.1	+375.8		+4.7			
					+[illegible].0	6	[illegible]			
"	14.5		49	34.1	+380.2		+4.5		+40.5	
					+382.4	6	22.4			
"	15.5		55	56.5	+384.8		+4.4			
					+387.2	6	26.8	+19	[illegible]	
"	18.[illegible]	11	2	23.7	+[illegible]4.1		+4.2			
					+391.0	6	31.0			
"	[illegible]	11	[illegible]	[illegible]47			+4.0			

									A'	A''	A'''
[illegible]	31	+1[illegible]	[illegible]	[illegible]	+[illegible]			+1,[illegible]			
					+44[illegible]	7	1[illegible]				
[illegible]	1.				+44 4,[illegible]			+1[illegible]			
					+4[illegible]	7	1[illegible]		+11 [illegible]		
	2.	+1[illegible]	[illegible]	1,1	+4[illegible]			+1.			
					+44 [illegible]	7	1[illegible]				
	[illegible]		[illegible]	[illegible]	+44 2,1			+1,4		112,5	
					+4[illegible]	7	17.				
	[illegible]		14	[illegible]	+4[illegible]			+1.			
					+44 1,4	7	11,1		+21	57,5	−3,1
			22	12,4	+44 1,1			+1,[illegible]			
					+44[illegible]	7	2[illegible]				
	[illegible]		2[illegible]	[illegible],7	+441			+[illegible]		+7,4	
					+44[illegible]	7	2[illegible],2				
	7.		[illegible]	[illegible]	+441,[illegible]			+1,1			
					+440,7	7	2[illegible]		+2[illegible]	[illegible]	−3,6
	[illegible]		4[illegible]	[illegible],7	+44[illegible]			+1,7			
					+44[illegible]	7	[illegible]				
	9.		[illegible]1	[illegible],6	+442,1			+1,6		+[illegible]	
					+442,4	7	[illegible]				
	10		[illegible]1	[illegible],0	+44[illegible]			+1,[illegible]			
					+44[illegible]	7	[illegible],2		+[illegible]	12,7	−2,1
	11	+14	[illegible]	27,6	+444,6			+[illegible]			
					+444,7	7	2[illegible]				
	12.		1[illegible]	[illegible]2.	+44[illegible]			+1.		+2,9	
					+444,9	7	[illegible],7				
	13		21	17,2	+44[illegible]			+1,[illegible]			
					+44[illegible]	7	[illegible],2		+[illegible]		
	14.		28	4[illegible]	+44[illegible]			+[illegible]			
					+4[illegible]	7	[illegible]				
	[illegible]		36	7,8							

Date 1887	G. M. T.	App. A.R.	log. p. Δ	App. Decl.	log. p. Δ	Mag.	Place.	authority B.G.	No.
Oct. 11,	8h 18m 33s:	1h 14m 14s.32	9.551n −0.37	+12° 5′ 43″.5	0.705 +5.3	10.1	Cincin.	307	1
" 12,	15 36 8:	1 13 14.14	9.467 +0.31	+11 58 26.7	0.810 +6.7	9.6	Königsberg,	307	2
" 13,	9 51 14:	1 12 30.20	9.280n −0.20	+11 52 58.0	0.729 +5.6	10.0	Vienna,	306	3
" 13,	11 31 22:	1 12 24.82	8.309n −0.02	+11 52 26.8	0.746 +5.5	10.0	Düsseldorf,	306	4
" 13,	13 26 48:	1 12 19.41	9.419 +0.27	+11 51 45.7	0.668 +4.9	10.0	Rome,	306	5
" 13,	9 15 39:	1 12 17.24	9.423n −0.25	+11 51 22.0	0.683 +5.0	10.2	Cincin.,	307	6
" 14,	8 57 24:	1 11 33.53	9.497n −0.33	+11 45 51.9	0.609 +4.2	--	Cincin.,	308	7
" 14,	9 21 51:	1 11 32.90	9.436n	+11 45 47.1	0.553	--	Algier,	308	8
" 14,	12 4 1:	1 11 25.60	9.325	+11 44 51.9	0.725	--	Paris,	307	9
" 14,	12 14 10:	1 11 25.18	9.470 +0.06	+11 44 49.0	0.726 +5.5	--	Paris,	307	10
" 14,	8 34 47:	1 11 22.10	9.500n	+11 44 26.2	0.696	10.0	Cincin.,	308	11
" 15,	8 52 5:	1 10 36.76	9.496n −0.33	+11 38 38.2	0.611 +4.3	...	Algier,	308	12
" 15,	9 52 17:	1 10 34.67	9.318n	+11 38 22.6	0.588	...	Algier,	308	13
" 15,	12 1 54:	1 10 28.89	9.375	+11 37 38.6	0.726	10.5	Paris,	307	14
" 16,	9 41 24:	1 9 38.36	9.347n	+11 31 4.2	0.737	...	Paris,	307	15

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Oct. 16,	14h	0m	25s:	1h	9m	30s.34	9.354 +0.22	+11	24	51.1	0.781	9.5	Berlin, 307	16
" 16,	13	56	39:	1	9	29.71	9.432 +0.28	+11	29	59.6	0.67[illegible]	10.0	Rome, [illegible]	17
" 17,	9	2	39:	1	8	44.65	9.448u +0.29	+11	24	1.9	0.6[illegible]	.	[illegible]	18
" 17,	9	24	41:	1	8	44.61	9.383u −0.25	+11	23	54.4	[illegible]	. .	Algier, 308	19
" 17,	13	13	19:	1	8	36.14	9.266 +0.19	+11	23	0.5	0.732 −4.1		Vienna 308	20
" 18,	12	7	34:	1	7	42.94	8.973	+11	16	1.7	0.654	10.2	Rome, (BR) 307	21
" 19,	8	58	6:	1	6	43.21	9.390u −0.25	+11	7	52.5	0.687	10.0	Clinton 308	22
" 19,	9	16	48:	1	6	42.40	9.332u −0.22	+11	7	46.3	0.682	. .	Clinton 308	[illegible]
" 20,	9	31	41:	1	5	59.45	9.259u −0.17	+11	2	4.4	0.6[illegible]	10	Toulouse, 308	24
" 20,	13	31	14:	1	[illegible]	52.20	9.328 +0.22	+11	1	0.4	0.78[illegible]	9.5	Berlin, 307	25
" 21,	9	7	13:	1	5	7.83	9.329u	+10	54	54.7	[illegible]	10	Toulouse, 308	[illegible]
" 21,	11	53	27:	1	5	3.79	8.892	+10	54	1[illegible].2	0.771	9.	[illegible]	27
" 21,	8	11	28:	1	4	59.50 [illegible].27	9.460u 9.47[illegible] −[illegible]	+10	[illegible]	[illegible]	0.7[illegible]	10.11	[illegible]	[illegible]
" 22,	8	53	25:	1	4	16.71 −[illegible]	9.343u −0.22	+10	46	16.4	0.695 +5.0	1[illegible]	[illegible]	[illegible]
23,	8	27	14:	1	3	29.43	9.357u	+10	41	0.7	0.745 +5.7		[illegible]	[illegible]

Oct. 26,	9h	17m	40s	1h	1m	[illegible]	[illegible]	+10°	17'	39.6"	0.76[illegible]	10	Düsseldorf	307	[illegible]
" 26,	[illegible]	[illegible]	24s	1	0	[illegible]	[illegible]	+10	18	1[illegible].6	0.692	.	Clinton	308 [illegible]	[illegible]
" 27,	9	22	[illegible]	1	0	18.[illegible]	9.079[illegible]	+10	12	43.8	0.76[illegible]	10	Düsseldorf	308	[illegible]
" 31,	10	22	44s	0	57	22.77	[illegible]	+9	45	[illegible]	0.684	.	Clinton,	309	[illegible]
Nov. 2,	9	26	52s	0	56	12.66	[illegible]	+9	3[illegible]	10.6	0.68[illegible]	...	Clinton,	309	[illegible]
Nov. [illegible],	7	[illegible]	50s	0	54	40.61	[illegible]	+9	16	3[illegible].8	0.68[illegible]	10.4	Clinton	309	36
" 6,	9	6	[illegible]s	0	54	11.3[illegible]	[illegible]	+9	10	[illegible]	0.69[illegible]	..	Clinton	309	37
" 1[illegible],	9	27	13s	0	51	56.28	[illegible]	+8	29	56.8	0.74[illegible]	10.5	Vienna	308	[illegible]
" 1[illegible],	10	[illegible]	[illegible]s	0	51	[illegible].42	9.14[illegible]	+8	29	43.2	0.687	10.[illegible]	Rome (S.R.)	309	39
" 16,	8	57	29s	0	51	26.14	[illegible]	+8	29	13.3	0.776	10.7	Düsseldorf	309	[illegible]
Nov. 18,	7	17	10s	0	51	15.[illegible]	[illegible]	+8	22	5[illegible].8	0.70[illegible]	..	[illegible]	311	41
" 18,	8	31	31s	0	51	[illegible]	[illegible]	+8	22	44.3	0.70[illegible]	...	[illegible]	[illegible]	41
" 21,	[illegible]	[illegible]	46s	0	51	17.[illegible]	[illegible]	+8	15	51.5	0.711	10.8	[illegible]	[illegible]	4[illegible]
[illegible],	6	54	[illegible]s	0	54	[illegible]	[illegible]	+8	6	10.1	0.77[illegible]	11.[illegible]	[illegible]	[illegible]	44
" 6,	9	[illegible]	1s	0	[illegible]	[illegible].47	[illegible]	+8	8	[illegible]	0.79[illegible]	11.0	[illegible]	[illegible]	4[illegible]

[illegible]	9,	7h	[illegible]	16:	[illegible]	57	[illegible]	[illegible]	+8°	12'	50,6	0,706	[illegible]	[illegible]	311	46
"	11,	7	9	[illegible]	0	58	45,68	8,714	+8	16	30,9	0,701	[illegible]	[illegible]	311	47
"	13,	7	1	57:	1	0	[illegible]	[illegible]	+8	20	58,1	0,700	11,2	Clinton,	311	4[illegible]
1888 Jan.	5,	8	7	43:	1	22	27,34	9,2[illegible]	+9	56	1,7	0,692	12	[illegible]	12	49
"	11,	8	4[illegible]	57:	1	29	55,10	9,4[illegible]1	+10	31	16,3	0,[illegible]	12,3	Clinton,	314	[illegible]
"	14,	8	1	56:	1	33	48,44	9,[illegible]4	+10	49	51,2	0,[illegible]7	12,1	[illegible]	314	[illegible]1
"	15,	7	46	31:	1	34	46,95	9,270	+10	54	17,6	0,737	[illegible]	[illegible]	12	52
"	31,	8	29	6:	1	58	14,88	9,[illegible]	+12	46	9,6	0,691	12,5	[illegible]	14	[illegible]
Feb.	[illegible]	[illegible]	5	41,	2	2	52,00	9,471	+13	7	50,2	0,681	12,7	Clinton	314	54
"	6,	8	7	51:	2	7	36,42	9,509	+13	29	44,6	0,682	12,5	Clinton,	314	[illegible]
"	[illegible],	[illegible]	7	18:	2	10	45,56	9,517	+13	44	30,1	0,682	12,4	[illegible]	314	[illegible]
"	13,	7	4[illegible]	[illegible]:	2	18	57,50	9,4[illegible]	+14	21	20,[illegible]	0,670	12,7	[illegible]	14	57
Mar.	9,	8	7	2[illegible]:	[illegible]	2	44,6[illegible]	9,610	+17	22	4[illegible],6	0,6[illegible]	1[illegible]	[illegible]	316	[illegible]

[illegible] Comparison Stars.

The following catalogue includes the stars of comparison arranged in their order of right ascension [illegible] are the star places used in making the observations for deriving the positions for the planet from October 11 1877 to March 12 1888.

[illegible] and references which have been consulted as Authorities for the positions: –

Authorities	Abbreviations.
Lamont's Catalogue	Lam.
Schjellerup's Catalogue.	Schj.
Weiss. Positiones Mediae + 15° – 15°	W.
Bonn Observations. Vol. VI.	Urg. VI.
Rümker's Catalogues.	R & R.
Ormah Catalogue.	Ormah
Yarnall's Catalogue.	Y.

[illegible] Cat. [illegible]	A. & S.
Lalande's Catalogue	[illegible]
Glasgow Catalogue	G. C.
Brünnow's Notices	B. N.
Astronomische Nachrichten	A. N.
Washington Observations	W. O.
Equatorial Comparisons	E. C.

The letter on positions of stars which have been differentiated from catalogue positions.

The weights to the catalogue positions have been given in accordance with the number of observations:

1 observation receiving the weight 1.

2 observations receiving the weight 2, &c.

In case the number of observations in any authority was not given the weight unity has been assigned.

The star places have been obtained in the [illegible] from all the observations, although in some cases new [illegible] of the observations of the same star when it seemed worthy of

a greater degree of confidence.

The reductions of the star places [illegible] in the following manner, using the formulae

$$\frac{d\alpha}{dt} = m + n \sin \alpha' \tan \delta'$$

$$\frac{d\delta}{dt} = n \cos \alpha'$$

where m and n are Struve's constants for the middle epoch, $\frac{1}{2}(t + t_0)$ and α' and δ' are the right ascension and declination for the [illegible] $\frac{1}{2}(t + t_0)$

$$\alpha = \alpha_0 + [m^s(t - t_0)] + [n^s(t - t_0)] \sin \alpha \tan \delta'$$

$$\delta = \delta_0 + [n''(t - t_0)] \cos \alpha'$$

[illegible] account the secular variation, and for stars ranging so near the equator as those under consideration, the third term of the precession would have no influence during the period of time involved.

As the left of the coordinates of the star places are given first the number of the star in order of A.R. and then the magnitude in parentheses. The published positions and data as taken from the Berlin Circular is indicated by B.C. and the number of the issue. The positions are for the epoch of the year in which they were used in making the observations. The notes and references are given in connection with each [illegible].

Catalogue.

No.	Mag.	R.A.	Decl.	Epoch 1887.0.
1.	(9)	$0^h\ 50^m\ 20^s.06$	$+9°\ 17'\ 40''.7$	

The star is W. 844. From B. 6. No. 309. Used at Clinton, U.S. 1887, Nov 5.

2.	(7.8)	$0^h\ 50^m\ 40^s.13$	$+8°\ 37'\ 2''.7$	

The position is 1/5 [Saut. + W. + R_2 + 2 Gl.]. From B.6. No. 309. Also given in 6. R. Used at Clinton, U.S. Nov. 13; also at Rome.

3.	(9.0)	$0^h\ 51^m\ 18^s.24$	$+8°\ 22'\ 18''.6$	

The place of this star is somewhat uncertain. E. 6. It has been used in making two observations of the planet. 1887 Nov [illegible]

Clinton, U.S. Positions given in B.C. No. 311.

4. (9.0) $6^h\ 51^m\ 19^s.42$; $+8^\circ\ 22'\ 1''.9$.

This is evidently the same star as No. 3, which was used at Clinton. The latter place has been taken as the planet position corrected by $-1^s.18$ in R.A. and in Decl. by $+17''$. Star used at Rome 1887, Nov. 21, from B.C. No. 310.

5. (9.1) $8^h\ 54^m\ 50^s.15$; $+3^\circ\ [illegible]\ 54''.7$.

The position is G. 516. and was used at Berlin, 1887, December 3, from A.N. No 2973; also B.C. No. 310. Washington Zone.

6. (1.5) 0^h [illegible] 11.62, $+8°$ $9'$ $49.8''$.

W. C. 519. From B. C. No. 311. Used at Clinton, U. S. 1887, December 6.

7. (7.8) 0^h 55^m $49^s.07$; $+9°$ $8'$ $9''.4$.

The position is 1/3 [W. C. 522 + [illegible] 254 + [illegible] 149]. Used at Clinton, U. S. 1887, [illegible] 6, from B. C. No. 309.

8. (7) 0^h 56^m $36^s.72$, $+8°$ $12'$ $51''.2$.

W. C. 229. Used at Clinton U. S., 1887, December 9. From B. C. No. 311.

9. (7) 0^h 56^m [illegible]; $+8°$ $31'$ $35''.4$.

The place is 1/2 [Arg. VI + W. C. 530]. Used at Dusseldorf, 1887, November 16. From B. C. No. 309.

10. (90) $0^h\ 57^m\ 14^s.31$; $+9°\ 4'\ 26''.7$.

The place is 1/2 [A.A. No. 1925 + A.A. No. 1800].

Used at Clinton, U.S., 1887, November 2. From B. C. No. [illegible]

11. (94) $0^h\ 57^m\ 21^s.61$; $+8°\ 22'\ 29''.6$. E. C.

Used at Clinton, U.S. 1887, December 13. This star was compared with 1/2 [Gl. 293 + Schj. 392], which gives: —

(8.2) $1^h\ 7^m\ 47^s.41$; $+8°\ 22'\ 31''.8$.

From B. C. No. 311.

12. (7.5) $1^h\ 5^m\ 4[illegible]$; $+[illegible]\ 1'\ 42''.5$.

The place is 1/3 [R. 510 + Schj. 366 + B. C. 128].

Used at Clinton, U.S. 1887, December 11. From B.C. No. 311.

13. (7) 1^h 1^m [illegible] ; + 1[illegible] [illegible] [illegible].

Gl. 272. Used at Florence, 1887, October 22, from B.C. No. 308.

14. (9) 1^h 1^m $44^s.96$; + 10° $43'$ $48''.1$.

The position is ½ [W. 1062 + [illegible] 50]. Used at Vienna, 1887, October 23, from B.C. No. 307.

15. (9) 1^h 2^m $28^s.29$; + 10° $15'$ $17''.9$.

The place is ⅓ [R. u.f. 521 + A.N. Vol. 51. 205 + Schj. 374]. Used at Düsseldorf, 1887, [illegible] 27, [illegible]

16. (9) 1^h 2^m $35^s.39$; + 10° $17'$ $20''.8$.

This star was used at Düsseldorf, 1887, October 26, and the place is R. 523, from B.C. No. 307. The position of star No. 17 was used instead as given at

16. Clinton, U. S. This gave a correction to the planet's place of $+0^{\circ}.27$ in A.R. and $-0''.8$ in Decl.

At Clinton for [illegible] 26, the positions of the planets depend on places as communicated by Professor Oudemans.

17. (9) $1^h\ 2^m\ 25^{\circ}.66$; $+1^{\circ}\ 17'\ 21''.6$.

The [illegible] is $1/3$ [W. C. 589 + R. 523 + $\frac{1}{3}$ (R. 521 + W. C. 586 + Schj. 3747)].

Used at Clinton U. S. [illegible] 1887. From B. C. No. 209.

18. (9) $1^h\ 5^m\ [illegible]$ $+11^{\circ}\ [illegible]\ 48''.9$.

W. C. 609. Used at Clinton, U. S. October, 14, 1887. From B. C. No. 308.

19. (9) $1^h\ 5^m\ [illegible]$, $+1[illegible]\ [illegible]\ [illegible]$.

The [illegible]

19. Berlin, 1887, October 21, from B.C. No. 307; also A.N. No. 2973. The position of No. 20 is adopted in the reduction of the observations.

20. (8.4) $1^h\ 5^m\ 53^s.18$; $+10^\circ\ 52'\ 0''.8$. E.C.

Comparisons from 1/3 [W. 119 + 2 B.N. 4], made at Clinton, [illegible] this gives for the comparison star (9.0) $1^h\ 10^m\ 12^s.19$; $+10^\circ\ 52'\ 14''.2$. This place has been adopted for observations depending on this star which were made at Berlin. From B.C. No. 308.

21. (9) $1^h\ 6^m\ 49^s.36$; $+11^\circ\ 23'\ 31''.7$.

W.C. 613. Used at Paris, 1887, October 16. From B.C. No. 307. The position No. 22 as given at Vienna has been adopted.

22. (9) 1^h 6^m 49.40 ; + 11° 23′ 31.″3 .

W. C. 613. Used at [illegible] 1887. Oct. 17. From B.C. No. 303. This place has been used for the Paris observation and also for that of Algiers. For Rome it is given as

(8.9) 1^h 6^m $49^s.69$; + 11° 23′ 32.″2 being

½ [W. 62 + Lan. 665]. From B. C. No. 307, 1887. Oct. 16.

23. (8.9) 1^h 6^m $49^s.79$; + 11° 23′ 33.″2 .

Same [illegible] as above W. 62.

24. (8.3) 1^h 7^m $9^s.61$; + 11° 8′ 58.″1 .

W. C. 615. Place used at Clinton, U.S. 1887. Oct. 19. From B. C. No. [illegible]

25. (8.3) 1^h 7^m $11.^s99$; $+11°$ $4'$ $58.''1$.

G. 616, used at Berlin, 1887, October 20, from A.N. No. 2923; also B.C. No. 307.

26. (7.8) 1^h 7^m $11.^s99$ $+11°$ $4'$ $58.''1$.

Same star and place as the preceding, used at Berlin 1887, October 19, from B.C. No. 307.

27. (8.9) 1^h 7^m $12.^s01$; $+11°$ $4'$ $58.''0$

This position is $\frac{1}{3}$ [W.66 + W.C. 616 + Lam. 167].

Used at Toulouse, 1887, Oct. 20, from B.C. No. 308.

28. (10) 1^h 7^m $32.^s27$; $+11°$ $31'$ $54.''3$.

Lam. 169. Used at Berlin, 1887, October 16, from B.C. No. 307; also A.N. No. 2973.

29. (10) $1^h\ 10^m\ 16^s.81$; $+11°\ 51'\ 27''.3$, E.C. 1865.

Determined at Clinton U.S.

and used at Clinton, 1887.

Oct. 13. From B.C. No. 307.

30. (9) $1^h\ 11^m\ 39^s.13$; $+11°\ 42'\ 3.6$, E.C.

Comparisons with W. C. 610. (7)

$\alpha = 1^h\ 6^m\ 2[illegible].06$

$\delta = +11°\ 41'\ 0''.6$.

Used at Paris 1887, October 14,

[illegible]. From B.C. [illegible] 307.

31. ([illegible]) $1^h\ 11^m\ 39^s.17$; $+11°\ 42'\ 4''.0$

Lam 179. Used at Rome, 1887,

October 13. From B.C. No. 306.

33. (8) $1^h\ 13^m\ 44^s.99$; $+11°\ 33'\ 7''.3$. W. 179.

This star was used in making the observations of the planet. Have adopted the position of α for this place

as given by [illegible] from B.C.
No. 308.

34. (8) $1^h\ 13^m\ 45^s.06$; $+11°\ 15'\ 7''.3$, W. 174.
(This place has also been used for the observation of the planet [illegible] Algier, [illegible] 7. Oct. 15) used at Königsberg, 1887, Oct. 12, from B.C. No. 307.

35. (9) $1^h\ 13^m\ 57^s.92$; $+11°\ 35'\ 34''.7$.
W. 184, used at Algier, 1887, Oct. 14, from B.C. No. 308.

36. (7) $1^h\ 15^m\ 59^s.45$; $+12°\ 0'\ 45''.2$.
The place is ½ [Pon. 191 + A.N. Vol. 72. 317]. Used at Vienna, 1887, Oct. 13, from B.C. No. [illegible].

37. (10) $1^h\ 16^m\ 15^s.34$; $+12°\ 4'\ 3''.7$. Pon. 192.
Used at Cincinnati, U.S. 1887, Oct. 11. from B.C. No. [illegible].

[illegible]. ([illegible]) 1^h [illegible] $1^s.11$; + 11° 49' 12".[illegible], [illegible] 19[illegible].

Used at Düsseldorf, 1887. Oct. 13.

From B. C. No. 306.

The following stars are for the Epoch

[illegible]

39. (9.5) 1^h 20^m $25^s.03$; + 9° 57' 40".1, W. 304.

Used at Clinton, U. S. 1888.

January 5. From B. C. No. 312.

40. (9.5) 1^h 31^m $6^s.31$; + 10° 33' 8".1, E. C.

[illegible] at Clinton, U. S.

[illegible] with [illegible] W. 64 + R [illegible],

and used in observing planet,

1888, January 11. From B. C. No. 314

41. (11.5) 1^h $3[illegible]^m$ 36.[illegible]; + 10° [illegible] [illegible] E. C.

The [illegible] stars [illegible]

[illegible] + [illegible] [illegible]

Clinton, U. S. 1888, Jan. 14.

[illegible]

42. (9.5) 1^h 36^m $57^s.87$; $+10°$ $57'$ $50''.2$, E.C.

Comparisons with Ast. Vol. 32, 217.

(9) $\alpha = 1^h$ 35^m 41.14,

$\delta = +11°$ $3'$ $50''.8$.

Used at [illegible], January 15, from B.C. [illegible] 12.

43. (9.4) 1^h 58^m $8^s.23$; $+12°$ $4'5$ $36''.8$, E.C.

Comparisons with 1/5 [W. 1029 + 2 Lan. 281 + 2 Gl. 456], which gives 1^h 59^m $44^s.32$; $+12°$ $48'$ [illegible].

Determined and used at Clinton, U.S., 1888, January 31, from B.C. 314.

44. (9.0) 2^h 3^m $52^s.75$; $+13°$ $29'$ $37''.4$.

Place from Ast. No. 2325, Used at Clinton, U.S. 1888, February 6, from B.C. No. 314.

45. (8.5) 2^h 4^m $47^s.78$; $+13°$ $9'$ $27''.5$.

This place is the mean of W. 21; Struve's C. G. 200; Pan. 788; R. 1089; Pala. AN. 2325, Used at Clinton, U.S., 1888, Feb. 3, from B.C. No. 314.

46. (8.8) 2^h 11^m $41^s.81$; $+13°$ $43'$ $44''.9$, E.C.

Comparisons with W. 1003, Determined and used at Clinton, U.S., 1888, Feb. [illegible], from B.C. [illegible]

47. ([illegible]) 2^h 17^m $18^s.40$; $+14°$ $20'$ $21''.[illegible]$, E.C.

Comparisons with W. 262, Determined at Clinton, U.S., 1888, February 13, from B.C. No. 314.

48. (10) 3^h 14^m $31^s.48$; $+17°$ $24'$ $19''.7$

Art. No. 2174, used at Clinton, U.S., [illegible], March 9, from B.C. No. [illegible]

With the preceding data we will now compute the residuals, $\Delta\alpha$ and $\Delta\delta$, in the following

$$\left.\begin{array}{l} C = \text{computed place} \\ O = \text{observed place} \end{array}\right\} \alpha \text{ and } \delta.$$

1887										Δα	Δδ
Oct. 11.5000	6α	1h	14m	16.[illegible]	6δ	+12	[illegible]	15.5″		−57.49	−42.1.8
Red. for +0.0502				−2.[illegible]				−21.2		1.75759n	
Oct. 11.5502	6α	1	14	14.[illegible]	6δ	+12	[illegible]	54.3		8.70070	Clinton.
" "	0α	1	14	13.[illegible]	0δ	+12	[illegible]	40.8		2.[illegible]11n	
	0−6			+0.[illegible]5				0.6			
Oct. 12.5000	6α	1	13	19.42	6δ	+11	59	11.4		−57.40	−426.2
Red for +.0877				−[illegible]				−[illegible]74		1.7[illegible]41n	
Oct. 12.5877	6α	1	13	14.[illegible]	6δ	+11	58	[illegible]		[illegible]	[illegible]
" "	0α	1	13	14.4[illegible]	0δ	+11	5[illegible]	33.4		2.62[illegible]	
	0−6			+[illegible]				−0.6			
Oct. 13.5000	6α	1	12	22.07	6δ	+11	52	[illegible]		−57.21	−[illegible]
Red for −.1403				+[illegible]				+60.3		1.75747n	
Oct. 13.3597	6α	1	12	[illegible]	6δ	+11	53	[illegible]		[illegible]	[illegible]
" "	0α	1	12	[illegible]	0δ	+11	53	3.6		2.63347n	
	0−6			−0.10				0.0			
Oct. 13.5000	6α	1	12	22.07	6δ	+11	52	3.3		−57.23	−429.8
Red for −0.0442				+2.[illegible]				+17.[illegible]		1.[illegible]767n	
Oct. 13.4358	6α	1	12	24.6[illegible]	6δ	+11	52	22.3		8.64542n	Dürrel Prof.
" "	0α	1	12	24.8[illegible]	0δ	+11	52	26.6		2.63327n	
	0−6			+[illegible].16				+4.3			
Oct. 13.5000	6α	1	12	22.07	6δ	+11	52	3.3		−57.23	−429.8
Red. for +.0201				−1.[illegible]				−[illegible].6		1.[illegible]62n	
Oct. 15.5201	6α	1	12	20.92	6δ	+11	51	54.7		8.30320	Rome.
" "	0α	1	12	20.6[illegible]	0δ	+11	51	50.6		2.63327n	
	0−6			−0.24				−4.1			
Oct. 13.5000	6α	1	12	22.07	6δ	+11	52	3.3		−57.21	−429.5
Red +.0898				−[illegible]14				−38.6		1.75747n	Clinton
Oct. 13.5898	6α	1	12	16.93	6δ	+11	51	24.7		8.95328	Algier.
"	0α	1	12	16.96	0δ	+11	51	27.0		2.63296n	
	0−6			+[illegible]				+2.3			

											$\Delta\alpha$	$\Delta\delta$
Oct.	14.5000	6α	1h	11m	24.96	6δ	+11°	44′	51.8″		−56.95	−432.7
Red. for	−.1408				+[illegible]				+60.9		1.75549n	
Oct.	14.3592	6α	1	11	[illegible]	[illegible]	+11	45	52.7		9.14860n	Algier.
"	"	0α	1	11	2.88	[illegible]	+11	45	56.1		2.63619n	
		O−C			0.10				−3.4			
Oct.	14.5000	6α	1	11	24.96	6α	+11	44	51.8		−56.95	−432.7
Red. for	−0.1238				+7.0[illegible]				+53.6		1.75549n	
Oct.	14.3762	6α	1	11	32.01	6δ	+11	45	45.4		9.09272n	Algier.
"	"	0α	1	11	32.62	[illegible]	+11	45	50.8		2.63619n	
		O−C			+0.[illegible]1				+5.4			
Oct.	14.5000	6α	1	11	24.96	6α	+11	44	51.8		−56.93	−432.8
Red. for	−.0492				+0.5[illegible]				+4.0		1.75534n	
Oct.	14.4908	6α	1	11	[illegible]	6δ	+11	44	55.8		7.96379n	Paris.
"	"	0α	1	11	2[illegible].65	0δ	+11	44	57.4		2.63629n	
		O−C			+0.17				+1.6			
Oct.	14.5000	6α	1	11	24.96	6δ	+11	44	51.8		−56.93	−432.8
Red. for	−.0422				+0.13				+1.0		1.7[illegible]4n	
Oct.	14.4978	6α	1	11	2[illegible].09	6δ	+11	44	52.8		7.34242n	Paris.
"	"	0α	1	11	2[illegible].24	0δ	+11	44	54.5		2.63629n	
		O−C			+0.1[illegible]				+1.7			
Oct.	14.5000	6α	1	11	24.96	6δ	+11	44	51.8		−56.91	−432.7
Red.	+.0614				−3.47				26.6		1.75519n	
Oct.	14.5614	6α	1	11	21.47	6δ	+11	44	25.2		8.78817	Clinton.
"	"	0α	1	11	21.77	0δ	+11	44	31.4		2.63619n	
		O−C			+0.30				+6.2			
Oct.	15.5000	6α	1	10	28.21	6δ	+11	37	37.8		−56.55	−434.8
Red. for	−.1446				+[illegible]				+62.[illegible]		[illegible]	
Oct.	15.3554	6α	1	10	[illegible]	6δ	+11	38	40.7		9.16017n	Algier.
"	"	0α	1	10	[illegible]	0δ	+11	38	42.4		2.63829n	
		O−C			+0.[illegible]				+1.7			

Oct.	15.5000	6α	1	10	28.21	6δ	+11	37′	37.″8	−56.55 −434.″8
[illegible]	−.1[illegible]7				[illegible]				+[illegible]4.6	1.75243u
Oct.	15.3463	6α	1	[illegible]	[illegible]	[illegible]	+11	38	22.4	9.01157u Algier.
"	"	0α	1	10	4.66	[illegible]	+11	[illegible]	26.6	2.63829u
		0−6			+[illegible]44				+4.2	
Oct.	15.5000	6α	1	10	28.21	6δ	+11	37	37.8	−56.54 −434.8
Red. for −.0107					+0.61				+4.7	1.75[illegible]u
Oct.	15.4893	6α	1	10	[illegible]	6δ	+11	37	42.[illegible]	8.02938u [illegible]
"	"	0α	1	10	[illegible].94	0δ	+11	37	44.1	2.63829u
		0−6			+[illegible].12				+1.6	
Oct.	16.5000	6α	1	9	31.9[illegible]	[illegible]	+11	30	22.0	−56.02 −436.4
Red. for −.1083					+[illegible].07				+47.3	1.74834u
Oct.	16.3917	6α	1	9	[illegible].00	6δ	+11	31	9.3	9.03463u Paris.
"	"	0α	1	9	[illegible].17	[illegible]	+11	31	9.9	[illegible]
		0−6			+0.17				+[illegible].6	
Oct.	16.5000	6α	1	9	31.93	6δ	+11	30	22.0	−55.99 −436.4
Red. for +.0408					−2.28				−1[illegible]	1.74811u Berlin.
Oct.	16.5408	6α	1	9	29.65	6δ	+11	30	4.2	[illegible]
"	"	0α	1	9	30.57	0δ	+11	29	57.4	2.63988u
		0−6			+[illegible].70				−6.8	
Oct.	17.5000	6α	1	8	36.25	6δ	+11	23	5.1	−55.38 −437.1
[illegible]	−.1372				+7.60				+60.0	1.74[illegible]
Oct.	17.3628	6α	1	8	4[illegible].85	6δ	+11	24	[illegible].1	[illegible] Algier.
"	"	0α	1	8	44.36	0δ	+11	24	6.1	2.64058u
		0−6			+[illegible].51				+1.0	
Oct.	17.5000	6α	1	8	36.25	6δ	+11	23	5.1	[illegible]
Red. for −0.1219					+6.60				+52.1	1.74335u
Oct.	17.3781	6α	1	8	42.[illegible]	6δ	+11	23	57.2	[illegible]
"	"	0α	1	[illegible]	43.[illegible]6		+11	23	58.5	2.64058u
		0−6			+[illegible]				+[illegible]	

											1.	1.
Oct.	17.5000	6α	1	8	36.25	6δ	+11°	23′	5.1″	−55.35	−437.1″	
Red. for −.0001					+0.01				+0.1	1.74312		
Oct.	17.4999	6α	1	8	36.26	6δ	+11	23	5.2	6.00000	Vienna.	
"	"	0α	1	8	36.33	0δ	+11	23	6.1	2.64058		
		O−C			+[illegible]				+[illegible]			
Oct.	18.5000	6α	1	8	41.33	6δ	+11	15	47.8	−54.66	−437.1	
Red. for .0350					+1.91				+15.3	1.73767		
Oct.	18.4650	6α	1	8	43.24	6δ	+11	16	3.1	8.54407	Rome.	
"	"	0α	1	8	43.04	0δ	+11	16	6.4	2.64058		
		O−C			−0.20				+3.3			
Oct.	19.5000	6α	1	6	46.98	6δ	+11	8	30.9	−53.75	−436.3	
	+.0775				−4.17				−33.8	1.73038		
Oct.	19.5775	6α	1	6	42.81	6δ	+11	7	57.1	8.88930	Clinton, U.S.	
"	"	0α	1	6	42.96	0δ	+11	7	57.5	2.63978		
		O−C			+0.15				+0.4			
Oct.	19.5000	6α	1	6	46.98	6δ	+11	8	30.9	−53.75	−436.3	
Red. for +.0904					−4.86				−39.4	1.73038		
Oct.	19.[illegible]904	6α	1	6	42.12	6δ	+11	7	51.[illegible]	8.[illegible]617	[illegible]	
"		0α	1	6	42.18	0δ	+11	7	51.3	2.63979		
					+0.06				−0.2			
Oct.	20.5000	6α	1	5	53.58	6δ	+11	1	15.1	−52.96	−434.9	
Red. for −.1127					+5.97				+49.0	1.72395		
Oct.	20.3873	6α	1	5	59.61	6δ	+11	2	4.1	9.05192	Toulouse.	
"		0α	1	5	59.26	0δ	+11	2	9.4	2.63839		
		O−C			−0.35				+5.3			
Oct.	20.5000	6α	1	5	53.58	6δ	+11	1	15.1	−52.88	−434.8	
Red. for +.0205					−1.08				−8.9	1.72329		
Oct.	20.5205	6α	1	5	52.50	6δ	+11	1	6.2	8.31175	Berlin	
"	"	0α	1	5	52.42	0δ	+11	1	6.6	2.63829		
		O−C			−0.08				+0.4			

									Δα	Δδ
Oct. 21.5000	6α	1	5	1.19	6δ	+10	54	1.3	−51.92	−432.3
Red. for −.1297				+6.7[illegible]				+7 [illegible] 1	1.71[illegible]	
Oct. 21.3703	6α	1	5	7.92	6δ	+10	54	57.5	9.1117[illegible]	[illegible]
"	0α	1	5	7.61	0δ	+10	54	59.7	2.[illegible]	
	0−6			−0.31				+2.2		
Oct. 21.5000	6α	1	5	1.19	65	+10	54	1.3	−51.89	−432.3
Red. for −.0474				+2.46				+20.5	1.71508	
Oct. 21.4526	6α	1	5	3.65	6δ	+10	54	21.8	8.67578	Berlin.
" "	0α	1	5	3.87	0δ	+10	54	24.2	2.60579	
				+0.22				+2.4		
Oct. 21.5000	6α	1	5	1.19	6δ	+10	54	1.3	−51.[illegible]	431.4
Red. for +.0451				−2.34				−19.5	1.71483	
Oct. 21.5421	6α	1	4	58.85	6δ	+10	53	41.8	8.65410	Chicago.
" "	0α	1	4	59.20	δ	+10	53	43.6	2.63584	
	0−6			+0.35				+1.8		
Oct. 22.5000	6α	1	4	9.84	6δ	+10	46	50.2	−50.84	−41[illegible].6
Red. for −.1393				+7.95				+58.5	1.70641	
Oct. 22.3607	6α	1	4	16.79	6δ	+10	46	48.7	9.13345	Toulouse.
" "	0α	1	4	16.49	δ	+10	46	41.4	2.63306	
	0−6			−0.30				−7.3		
Oct. 23.5000	6α	1	3	17.61	6δ	+10	37	4[illegible]	−49.74	−426.1
Red. for .1920				+9.55			+1	21.8	1.69671	
Oct. 23.3080	6α	1	3	27.16	6δ	+10	41	4.1	9.28330	
"	0α	1	3	27.20	δ	+10	41	6.6	2.62951	Vienna.
				+0.04				+2.5		
Oct. 26.5000	6α	1	0	56.35	6δ	+10	18	45.7	−45.70	−411.2
Red. for −.1373				+6.26				+56.5	1.66020	
Oct. 26.3627	6α	1	1	2.86	6δ	+10	19	42.2	9.1[illegible]	[illegible]
	α	1	1	2.66	0δ	+10	19	45.4	2.61405	
				−0.20				+3.2		

										$\Delta\alpha$	$\Delta\delta$
Oct.	27.5000	6α	1h	0m	11.67	6δ	+10°	11′	57.8	−44.27	−40[illegible]
[illegible]	−.1[illegible]				[illegible]				+[illegible]4.1	[illegible]	
Oct.	27.3660	6α	1	0	1[illegible]	6δ	+10	12	52.0	1.12710n	Clinton.
"	"	0α	1	6	1[illegible]	0δ	+10	12	49.6	2.60746n	
		0−6			[illegible]				−2.4		
Oct.	31.5000	6α	0	57	22.47	6δ	+9	45	57.6	−37.65	−373.4
Red. for	+.[illegible]59				−5.12				−50.7	1.57576n	
Oct.	31.6359	6α	0	7	22.37	6δ	+9	45	6.9	[illegible]	[illegible]
"	"	0α	0	57	22.78	0δ	+9	4[illegible]	[illegible]7	2.57217n	
		0−6			+0.41				+0.8		
Nov.	2.5000	6α	0	56	[illegible]47	6δ	+9	[illegible]	4[illegible].1	−34.12	−355.4
Red. for	+.0971				−3.31				−34.5	1.53301n	
Nov.	2.5971	6α	0	56	12.16	6δ	+9	[illegible]	12.6	8.9[illegible]722	Clinton.
"	"	0α	0	56	11.58	0δ	+9	3[illegible]	1[illegible]	2.55072n	
		0−6			+0.42				+2.7		
Nov.	5.5000	6α	0	54	41.02	6δ	+9	16	43.3	−[illegible]8.64	[illegible]2.4
Red. for	+.0303				−0.87				−9.[illegible]	1.4[illegible]17n	
Nov.	5.5303	6α	0	54	[illegible]	6δ	+9	16	33.4	8.48144	Clinton.
"	"	0α	0	54	[illegible]	0δ	+9	16	37.4	2.51242n	
		0−6			+0.2[illegible]				+4.0		
Nov.	6.5000	6α	0	54	12.26	6δ	+9	11	23.0	−26.79	−324.3
Red. for	+.0830				−2.22				−26.1	1.42[illegible]7n	
Nov.	6.5830	6α	0	54	11.04	6δ	+9	10	56.9	8.91908	Clinton.
"		0α	0	54	11.27	0δ	+9	10	58.2	2.49734n	
		0−6			+0.2[illegible]				+1.3		
Nov.	13.5000	6α	0	51	[illegible]98	6δ	+[illegible]	39	24.7	−12.[illegible]	−[illegible]
	−.0580				+2.0[illegible]				+[illegible]6.7	1.112[illegible]4n	
Nov.	1[illegible].34	0α	0	51	56.03	6δ	+8	40	+1.4	[illegible]	[illegible]
"	"	0α	0	51	5[illegible].29	6δ	+8	40	2.4	2.36547n	
		0−6			+0.[illegible]6				+1.0		

											$\Delta\alpha$	$\Delta\delta$	
[illegible]	[illegible]		"	51	53.98	6δ	+ 8°	40′	24.7″		−12.92s	−231.6″	
Red. for	−.1008				+1.[illegible]				+2[illegible]		1.11116n		
Nov.	13.3992	6α	"	51	55.28	6δ	+ 8	39	48.0		9.00346n		Rome
"	"	0α	"	51	55.55	0δ	+ 8	39	47.6		2.36474		
	0 − 6				+0.27				−0.4				
Nov.	16.5000	6α	0	51	24.78	6δ	+ 8	28	49.9		−6.70	−193.1	
Red. for	−.1521				+1.02				+29.4		0.82607n		
Nov.	16.3479	6α	0	51	[illegible]	6δ	+ 8	29	19.[illegible]		9.1[illegible]		[illegible]
"	"	0α	0	51	26.12	0δ	+ 8	29	18.6		2.20970n		
	0 − 6				+0.32				−0.7				
Nov.	18.5000	6α	0	51	15.64	6δ	+ 8	22	52.5		−2.[illegible]	−16[illegible]	
Red.	+.0064				−0.02				−1.1		0.[illegible]794n		
Nov.	18.5064	6α	0	51	15.62	6δ	+ 8	22	51.4		7.80613		Clinton.
"	"	0α	0	51	15.14	0δ	+ 8	22	57.2		2.21801n		
	0 − 6				−0.48				+5.8				
Nov.	18.5000	6α	0	51	15.64	6δ	+ 8	22	52.5		−2.55	−165.5	
Red. to	+.0578				−0.15				−9.5		0.40654n		
Nov.	18.5578	6α	0	51	15.49	6δ	+ 8	22	43.0		8.76193		Clinton.
"	"	0α	0	51	15.07	0δ	+ 8	22	48.6		2.21748n		
	0 − 6				−0.42				+5.6				
Nov.	21.5000	6α	0	51	17.32	6δ	+ 8	15	36.8		+3.40	−126.3	
Red. for	.2958				−1.01				+37.4				
Nov.	21.2042	6α	0	51	16.31	6δ	+ 8	16	14.2		0.53148		
		0α	0	51	17.06	0δ	+ 8	15	55.8		9.471000n		Rome.
	0 − 6				+0.75				−18.4		2.10140n		
					−0.43				−3.6		[illegible]		
Dec.	3.5000	6α	0	54	20.4[illegible]	6δ	+ 8	6	21.[illegible]		+26.1[illegible]	+28.[illegible]	
Red. for	−.2565				−6.71				−7.2		1.41714		
Dec.	3.2435	6α	0	54	13.70	6δ	+ 8	6	14.3		9.40909n		Berlin.
"	"	0α	0	54	13.87	0δ	+ 8	6	15.0		1.44716		
	0 − 6				+0.17				+0.7				

												1.	1.
Dec.	6.5000	6α	0	55	47.29	68	+8°	8′	45.″3			+32.″44	+66.″2
Red. for	.1000				+31.4				+6.6			1.51808	
												9.00000	Clinton
Dec.	6.6000	6α	0	55	50.53	68	+8	8	51.9			1.82086	
"		0α	0	55	50.61	08	+8	8	54.1				
		0−6			+0.08				+2.2				
Dec.	9.5000	6α	0	57	29.38	68	+8	12	54.2			+36.49	+100.0
Red. for	−.0045				−0.16				−0.5			1.56217	
Dec.	9.4955	6α	0	57	29.22	68	+8	12	53.7			9.65321	Clinton.
" "		0α	0	57	29.28	08	+8	12	54.3			2.00000	
		0−6			+0.06				+0.6				
Dec.	13.5000	6α	1	0	8.05	68	+8	21	2.6			+42.79	+143.6
Red. for	−.0057				−0.24				−0.8			1.63134	
Dec.	13.4943	6α	1	0	7.81	68	+8	21	1.8			9.75587	Clinton.
" "		0α	1	0	8.01	08	+8	21	1.7			2.15715	
		0−6			+0.20				−0.1				
1888.													
Jan.	[illegible]	6α	1	22	27.00	68	+9	[illegible]	53.1			[illegible]	[illegible]
Red. for	+.0383				+2.70				+12.8			1.84733	
Jan.	5.5383	6α	1	22	27.70	68	+9	56	5.9			8.58320	Clinton.
" "		0α	1	22	27.95	08	+9	56	4.6			2.52257	
		0−6			+0.25				−1.3				
Jan.	11.5000	6α	1	29	50.42	68	+10	30	54.0			+77.04	+366.1
Red. for	+.0644				+4.46				+23.6			1.88672	
Jan.	11.5644	6α	1	29	55.38	68	+10	31	17.6			8.80889	Clinton.
"		0α	1	29	[illegible]	08	+10	31	17.1			[illegible]	
		0−6			−0.12				+1.5				
Jan.	14.5000	6α	1	33	45.49	68	+10	45	34.1			+79.65	+350.3
Red. for	+.0335				+2.67				+12.7			1.90119	
Jan.	14.533[illegible]	6α	1	33	48.16	68	+10	45	46.8			[illegible]	
		0α	1	33	48.56	08	+10	45	[illegible]			[illegible]	Clinton.
		0−6			+0.40				+7.1				

Jan. 15.5000	6α	1	35	5.57	6δ	+10	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]				−13.71			−1	21.1	1.10644	
Jan 15.2680	6α	1	34	46.86	6δ	+10	54	27.4	9.36549	Vienna.
" "	0α	1	34	46.96	0δ	+10	54	22.2	2.58478	
	0−6			+0.10				−4.2		
Jan. 31.5000	6α	1	[illegible]	10.30	6δ	+12	45	50.2	+92.02	+403.3
Red. for +.0511				+4.70				+[illegible]	1.96[illegible]	
Jan. 31.5511	6α	1	[illegible]	[illegible]	6δ	+12	45	10.3	[illegible]	[illegible]
" "	0α	1	58	15.04	0δ	+12	46	12.0	2.60563	
	0−6			−0.04				+1.2		
Feb. 3.5000	6α	2	2	49.04	6δ	+13	7	35.2	+93.82	+437.2
Red. for +.0346				+3.25				+15.1	1.97230	
Feb. 3.5346	6α	2	2	52.29	6δ	+13	7	[illegible]	[illegible]	Clinton.
" "	0α	2	2	52.15	0δ	+13	7	52.[illegible]	2.64[illegible]	
	0−6			−0.14				+2.2		
Feb. 6.5000	6α	2	7	33.14	6δ	+13	29	32.7	+95.58	+441.3
Red. for +.0[illegible]				+3.43				+15.8	1.98037	
Feb. 6.5359	6α	2	7	36.[illegible]	6δ	+13	29	48.5	8.55509	Clinton.
" "	0α	2	7	36.57	0δ	+13	29	46.8	2.64473	
	0−6			0.00				−1.7		
Feb. 8.5000	6α	2	10	45.44	6δ	+13	44	15.7	+96.73	+442.4
Red. for +.0[illegible]				+3.43				+15.7	1.98556	
Feb. 8.5355	6α	2	10	48.87	6δ	+13	44	31.4	8.55023	Clinton.
	0α	2	10	49.01	0δ	+13	44	32.3	2.64582	
	0−6			+0.14				+0.9		
Feb. 13.5000	6α	2	18	55.79	6δ	+14	28	17.2	[illegible]	[illegible]
Red. for +.0181				+1.80				+8.0	1.[illegible]747	
Feb. 13.5181	6α	2	18	57.59	6δ	+14	28	25.2	8.25768	Clinton.
" "	0α	2	18	57.64	0δ	+14	28	22.4	2.44[illegible]	
	0−6			+0.05				−2.8		

1887 Table of Residuals.

G.M.T.		Δx	w	Δy	w	Observatories
Oct.	11.5502	−0.05	1	−5.5	1	Clinton U.S.
"	12.5877	−0.06	1	−0.6	1	[illegible]
	13.[illegible]97	−0.1[illegible]	1	[illegible]	1	Vienna
	13.4558	−0.2[illegible]	[illegible]	+4.3	1	Düsseldorf
"	13.5201	[illegible]	[illegible]	4.3	1	[illegible]
	13.5898	+0.[illegible]	1	+2.[illegible]	1	Clinton, U.S.
	14.5592	−0.[illegible]	[illegible]	+[illegible]4	1	Algier
"	14.3762	+0.61	[illegible]	+[illegible]	1	Algier
	14.4901	+0.17	1	+1.6	1	[illegible]
"	14.4978	+0.[illegible]	1	+1.7	1	Paris
	14.5614	+0.[illegible]	1	+[illegible]	1	Clinton, U.S.
"	15.3554	−0.02	[illegible]	+1.7	1	Algier
	15.3973	+0.37	[illegible]	+4.2	1	Algier
	15.4893	+0.12	1	+1.6	1	Paris
	16.3917	+0.17	1	+[illegible].6	1	Paris
"	16.5408	+0.98	¼	6.8	¼	Berlin
"	16.5408	+0.34	[illegible]	+0.3	1	Rome
"	17.3628	+0.12	[illegible]	−[illegible]	1	Algier
"	17.[illegible]1	+0.12	[illegible]	−[illegible]1	1	Algier
	17.4999	+0.[illegible]	1	+0.9	1	Vienna
	18.46[illegible]	−0.1[illegible]	[illegible]	+[illegible]	1	[illegible]
"	19.5775	+0.1[illegible]	1	+[illegible]4	1	Clinton
"	19.5904	+0.0[illegible]	1	[illegible]	1	Clinton
"	20.3873	[illegible]	[illegible]	+[illegible]	¼	[illegible]
	20.5205	[illegible]	[illegible]	+0.4	1	Berlin
	21.[illegible]	−0.31	¼	+2.2	1	Toulouse
"	21.4526	+0.2[illegible]	[illegible]	+[illegible]1	1	Berlin
"	21.5451	+0.[illegible]	1	+1.8	1	Clinton
	22.3607	−[illegible]	¼	[illegible]	¼	Toulouse
"	23.3080	+0.04	1	+2.[illegible]	1	Vienna
"	26.3627	+0.07	[illegible]	+[illegible]4	1	Düsseldorf
"	26.5737	+0.17	1	+[illegible]1	1	Clinton
"	27.366[illegible]	+0.[illegible]	1	+[illegible]	1	Düsseldorf
Nov.	2.5971	+0.42	1	+[illegible]7	1	Clinton
"	5.5303	+0.25	1	+4.0	1	Clinton
"	6.[illegible]	+[illegible]	1	+1.[illegible]	1	Clinton

[illegible]	[illegible]	[illegible]	1	[illegible]	1	[illegible]
	[illegible]	[illegible]		[illegible]	1	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	1	[illegible]	1	[illegible]
[illegible]	[illegible]	[illegible]	1	[illegible]	1	[illegible]
[illegible]	[illegible]	[illegible]	1	[illegible]	1	[illegible]
	[illegible]	[illegible]	1	[illegible]	1	[illegible]
[illegible]	[illegible]	[illegible]	1	[illegible]	1	[illegible]
[illegible]	[illegible]	[illegible]	1	[illegible]	1	[illegible]
[illegible]	11.644	−0.12	1	[illegible]	1	[illegible]
[illegible]	14.[illegible]	+0.40	1	+7.1	1	[illegible]
[illegible]	15.26[illegible]	+0.10	1	−4.2	1	[illegible]
[illegible]	31.5511	+0.04	1	+1.2	1	[illegible]
[illegible]	[illegible]	+0.14	1	+2.2	1	[illegible]
[illegible]	[illegible]	0.00	1	−1.7	1	[illegible]
[illegible]	[illegible]	+0.14	1	+0.7	1	[illegible]
	[illegible]	[illegible]	1	[illegible]	1	[illegible]
[illegible]	[illegible]	−0.1	1	[illegible]	1	[illegible]

Weighting the Observations

The residuals as tabulated in the preceding tables are weighted for each Observatory in the following manner: The mean of the residuals of each Observatory being obtained, the probable error of each residual is then found and the weight taken proportional to the reciprocal of the probable error. For example we have the residuals for the Observatory at Clinton, U. S. in R.A. as follows: —

vide next page

Clinton. U.S.

Δx		x	xx
−0.05 − .15	=	−0.20	.0400
+0.03	=	+0.12	.0144
+0.30	=	+0.15	.0225
+0.15	=	0.00	.0000
+0.06	=	−0.09	.0081
+0.35	=	+0.15	.0225
+0.17	=	+0.01	.0001
+0.40	=	+0.25	.0625
+0.42	=	+0.27	.0729
+0.25	=	+0.10	.0100
+0.23	=	+0.08	.0064
+0.08	=	−0.07	.0049
+0.06	=	−0.09	.0081
+0.09	=	−0.06	.0036
+0.20	=	+0.05	.0025
+0.25	=	+0.10	.0100
−0.12	=	−0.27	.0729
+0.40	=	+0.25	.0625
+0.04	=	−0.11	.0121
+0.14	=	−0.01	.0001
+0.14	=	−0.01	.0001
+0.05	=	−0.10	.0100
−0.01	=	−0.16	.0256
			$\Sigma xx = .4468$

$$z = \sqrt{\frac{\Sigma xx}{n-1}}$$

$$r = q\sqrt{\frac{\Sigma xx}{n-1}}$$

$q = .6745$

$\log \Sigma xx = 9.65011$

$\log n-1 \quad 1.[illegible]984$

$2/8.29027$

9.14513

$\log q \quad 9.82898$

8.97411

$r = 0.094$

Since the probable error of a residual of this observatory is a minimum as compared with the

probable errors of the other Observatories, we take the square root of the reciprocal of this probable error as weight unit and take the relative ratios of the probable errors of the residuals of the other Observatories considered in the same way for the respective weights. Proceeding in this manner we find the respective weights assigned in the preceding table, with the exception of a few observations which have been specially weighted

The observations will now be grouped in the following manner for the purpose of forming the equations of condition.

(vide next page)

(1)

Date 1887	α	Cα	O−C	W	δ	Cδ	O−C	W	Place.	Star No
Oct. 11.5502	[illegible]	[illegible]	−0.05	1	[illegible]	54.3	−5.5	1	Clinton	[37],
" 12.5877	14.45	14.[illegible]	+0.06	1	[illegible]	34.0	−0.6	1	Königsberg	[34],
" 13.5597	[illegible]	30.10	−0.10	1	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible],
" 13.4558	24.8[illegible]	24.60	[illegible]	[illegible]	26.6	22.3	+4.3	1	Düsseldorf	[38],
13.5201	[illegible]	20.92	−0.24	½	50.6	54.7	−4.3	1	Rome	[31],
" 13.5898	16.96	16.93	+0.03	1	27.0	24.7	+2.3	1	Clinton,	[29],
" 14.3592	[illegible]	[illegible]	−0.22	½	56.1	52.7	+3.4	½	Algier,	[35],
" 14.[illegible]762	[illegible]	32.01	+0.61	¼	[illegible]	45.4	+5.4	½	Algier,	[35],
14.4[illegible]	25.6[illegible]	25.48	+0.17	1	57.4	[illegible]	+1.6	1	Paris,	[30],
" 14.4978	25.24	25.[illegible]	+0.15	1	54.[illegible]	[illegible]	+1.7	1	Paris,	[30],
" 14.5614	21.77	21.47	+0.30	1	31.4	25.2	+6.2	1	Clinton,	[18],
			n = +0.04				n = +0.99			
			+0.60 W 9.				W 10			

(2)

Oct. 15.3554	36.[illegible]7	36.39	−0.02	½	42.4	40.7	+1.7	1	Algier,	[34],
" 15.3973	34.39	34.02	+0.37	½	26.6	22.4	+4.2	1	Algier,	[34],
" 15.4[illegible]	28.94	28.82	+0.12	1	44.1	42.[illegible]	+1.6	1	Paris,	[30],
" 16.3917	38.17	[illegible]	+0.17	1	9.9	9.3	+0.6	1	Paris,	[21],
" 16.5408	30.57	29.65	+0.90	¼	57.4	64.2	−6.8	½	Berlin,	[28],
" 16.5408	29.99	29.65	+0.34	½	4.5	4.2	+[illegible]	1	Rome,	[22],
" 17.3628	43.97	43.85	+0.12	½	4.9	5.1	−0.2	1	Algier	[22],
" 17.3781	43.97	42.85	+0.12	½	57.3	57.2	+0.1	1	Algier,	[22],
" 17.4999	36.33	36.26	+0.07	1	6.1	5.2	+0.9	1	Vienna,	[21],
" 18.4650	[illegible]	43.24	−0.13	1	6[illegible]	[illegible]	[illegible]	1	Rome,	[21],
			n = +0.1[illegible]				n = +1.20			
			+1.97 W 7				W 9			

(3)

Oct. 19.5775	42.96	42.81	+0.[illegible]	1	57.[illegible]	57.1	+0.4	1	Clinton,	[24],
" 19.5[illegible]4	42.[illegible]	42.11	+0.06	1	51.[illegible]	51.5	−0.2	1	Clinton,	[26],
" 20.3873	59.26	59.61	−0.35	¼	9.4	4.1	+5.3	¼	[illegible],	[27],
[illegible]	52.42	52.50	−0.0[illegible]	½	6.6	6.2	+0.4	1	[illegible]	[illegible]
" 21.37[illegible]	7.61	7.92	−0.31	¼	[illegible]	57.5	+2.2	1	[illegible]	[27],
" 21.4526	[illegible]	3.65	+0.2[illegible]	½	21.[illegible]	27.8	+0.1	1	Berlin,	[20],
" 21.5451	59.20	[illegible]	+0.35	1	[illegible]	41.8	+1.[illegible]	1	Clinton	[16]*,
" 22.3607	16.49	16.79	−0.30	¼	41.4	[illegible]	−7.[illegible]	¼	Toulouse	[13],
" 23.3080	29.[illegible]	29.16	+0.04	1	6.6	4.1	+2.5	1	Vienna,	[14],
			n = +0.08				n = +0.9			
			+1.2[illegible] W 6				W 8			

* [illegible]

Oct.	26.3627	2.93	2.86	−0.07	2/3	44.6	42.2	+2.4	1	Düsseldorf, [16].
	[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	1	[illegible]
"	27.3660	17.90	17.60	+0.30	2/3	49.6	52.0	−2.4	1	Düsseldorf [15].
	31.6359	22.78	22.37	+0.41	1	7.7	6.9	+0.8	1	Clinton [17].
Nov.	2.5971	12.58	12.16	+0.42	1	15.3	12.6	+2.7	1	Clinton, [11].
	5.5303	40.46	40.15	+0.25	1	37.4	33.4	+4.0	1	Clinton, [1].
"	6.[illegible]	11.27	11.04	+0.23	1	[illegible]	56.9	+1.3	1	Clinton [illegible].
			n = +0.22				n = +1.27			
			= +3.30 W.6				W. 7			
(5)										
Nov.	13.3420	56.29	56.03	+0.26	1	2.4	1.4	+1.0	1	Vienna, [2]
"	13.3992	55.55	55.28	+0.27	1/2	47.6	48.0	−0.4	1	Rome, [2].
"	16.3479	26.12	25.80	+0.32	2/3	18.6	19.3	−0.7	1	Düsseldorf [9].
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] [3]*
"	18.5578	15.07	15.49	−0.42	1/4	48.6	43.0	+5.6	5	Clinton, [3]*
"	21.2042	15.88	16.31	−0.43	[illegible]	12.8	04.2	−8.6	1/6	Rome [3]*
			n = +0.127				n = +0.23			
			= +1.91 W.3				W. 4			
(6)										
Dec.	3.2435	13.87	13.70	+0.17	1/2	15.0	14.3	+0.7	1	Berlin, [5].
"	[illegible]	[illegible]	[illegible]	[illegible]	1	54.1	[illegible]	+1.2	1	[illegible]
"	9.4755	29.28	29.22	+0.06	1	54.3	53.7	+0.6	1	Clinton, [8].
"	11.5000	45.64	45.55	+0.09	1	34.5	36.6	−2.1	1	Clinton, [12].
"	13.4943	8.01	7.81	+0.20	1	1.7	1.8	−0.1	1	Clinton, [10
1888.			n = +0.111				n = +0.26			
(7)			= +1.76 W.4				W.5			
Jan.	[illegible]	[illegible]	[illegible]	[illegible]	1	4.6	[illegible]	−1.3	1	Clinton, [39].
"	11.5644	55.26	55.38	−0.12	1	19.1	17.6	+1.5	1	Clinton, [40].
"	14.5335	48.56	48.16	+0.40	1	53.9	46.8	+7.1	1	Clinton [41].
"	15.2680	46.96	46.86	+0.10	1	20.6	21.2	−4.2	1	Vienna, [42].
			n = +0.157				+0.78			
			= 2.35 W.4				W.4			
Jan.	31.5511	15.04	15.00	+0.04	1	12.0	10.8	+1.2	1	Clinton, [43].
Feb.	3.5346	52.15	52.29	−0.14	1	52.5	50.3	+2.2	1	Clinton, [45].
			n = [illegible]				+1.7			
			= 0.75 W.2				W.2.			
Feb.	6.5359	36.57	36.57	0.00	1	46.8	48.5	−1.7	1	Clinton, [44].
"	8.5355	49.01	48.87	+0.14	1	32.3	31.4	+0.8	1	Clinton, [46].
"	[illegible]	[illegible]	[illegible]	[illegible]	1	22.4	[illegible]	[illegible]	1	Clinton [47]
			n = +0.06				−1.23			
			= +0.94 W.3				W.3			
March	9.5332	44.84	44.85	−0.01		45.5	48.1	−2.60		Clinton, [48].

*) Special weight.

Equations of condition

By dividing the observations into ten groups and taking the mean of the residuals of each group for the $\Delta\alpha$ and $\Delta\delta$, we form with these residuals twenty equations of condition, ten of them arising from the residuals in R.A. and ten from those in Decl. Let T for the time for which the equations of condition are formed, we then have the following quantities for the right hand members of the equations of condition

T	$\Delta\alpha$	W	$\Delta\delta$	W		
1887. Oct. 12.5	+ 0.60	9	+ 0.99	10	1887 Oct.	11 – 14
" " 16.5	+ 1.97	7	+ 1.20	9	" "	15 – 18
" " 20.5	+ 1.20	6	+ 0.90	8	" "	19 – 23
" Nov. 1.5	+ 3.30	6	+ 1.27	7	" "	26 – Nov. 6
" 17.5	+ 1.91	3	+ 0.23	4	" Nov.	13 – 21
" Dec. 7.5	+ 1.76	5	+ 0.26	5	" Dec.	3 – 13
1888. Jan. 11.5	+ 2.35	4	+ 0.78	4	1888 Jan.	5 – 15
" Feb. 3.5	– 0.75	2	– 1.70	2	" "	31 – Feb. 3
" " 9.5	+ 0.94	3	– 1.23	3	" Feb.	6 – 13
" Mar. 9.5	– 0.15	1	– 2.60	1	" Mar.	9.

The computation for the differential coefficients will be as follows:

Computations [illegible] XIII.

	[illegible] Col. 12	Col. 16	[illegible]	[illegible]	[illegible]
$\sin\alpha$	9.49746	9.47514	[illegible]	[illegible]	[illegible]
Δ	9.98079	9.98380	9.98851	0.01190	[illegible]
$\cos\alpha$	9.97740	9.97971	[illegible]	9.98652	[illegible]
$\frac{\sin\alpha}{\rho}$	9.51667	9.49134	[illegible]	9.37791	[illegible]
$\sin\delta$	9.31732	9.29980	9.28132	4.22482	[illegible]
$\frac{\cos\alpha}{\rho}$	9.99661	9.99591	[illegible]	[illegible]	[illegible]
$\cos\delta$	9.99043	9.99110	9.99192	[illegible]	[illegible]
ρ	9.98079	[illegible]	[illegible]	0.01190	0.05025
$\cos\delta\frac{d\alpha}{dx}$	9.51667_n	9.49134_n	9.46295	9.37791_n	9.28691_n
$\cos\delta\frac{d\alpha}{dy}$	9.99661	[illegible]	9.99230	9.97461	[illegible]
$\frac{d\delta}{dx}$	9.31393_n	9.29571_n	[illegible]	9.19944_n	9.09560_n
$\frac{d\delta}{dy}$	[illegible]	[illegible]	[illegible]	[illegible]	8.45285
$\frac{d\rho}{dz}$	0.00964	0.00739	[illegible]	9.95189	9.93601
$\cos(A+u)$	9.56554_n	[illegible]	[illegible]	[illegible]	[illegible]
x	0.26232	[illegible]	0.25553	[illegible]	[illegible]
$\cot(B+u)$	0.45386	[illegible]	0.38513	[illegible]	[illegible]
y	9.97600	[illegible]	9.93547	[illegible]	[illegible]
$\cot(C+u)$	0.31727	[illegible]	0.26104	[illegible]	[illegible]
z	9.31862	9.54281	[illegible]	[illegible]	[illegible]

	Oct. 12.5	Oct. 16.5	Oct. 20.5	Nov. 1.5	Nov. 17.5
ε	[illegible]	9.80553	9.83847	9.91617	[illegible]
$\cos\varepsilon$	[illegible]	9.96255	9.96255	9.96255	[illegible]
γ	[illegible]	[illegible]	0.25553	0.24307	[illegible]
$\sin\varepsilon$	[illegible]	9.59990	9.59990	9.59990	[illegible]
z	[illegible]	9.54281	9.56546	[illegible]	[illegible]
$\cos\varepsilon$	[illegible]	[illegible]	9.80102	[illegible]	[illegible]
$\sin\varepsilon$	0.11852	9.14271	9.16536	[illegible]	[illegible]
ε	0.71348	0.72014	0.72605	[illegible]	[illegible]
$\frac{dz}{d\delta}$	9.83200_n	[illegible]	9.89141_n	[illegible]	[illegible]
$\frac{dz}{d\pi}$	9.83116	9.86207	9.89065	[illegible]	[illegible]
ε	7.28500	7.25500	7.24500	7.19500	[illegible]
$\frac{dz}{d\delta}$	[illegible]	[illegible]	7.13565_n	7.16020_n	[illegible]
$\frac{dy}{d\delta}$	0.22487	0.22163	[illegible]	[illegible]	[illegible]
$\frac{dy}{d\pi}$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ε	8.07100	[illegible]	[illegible]	[illegible]	[illegible]
$\frac{dy}{d\delta}$	8.29587_n	[illegible]	[illegible]	[illegible]	[illegible]
$\frac{dz}{d\delta}$	9.86222	[illegible]	9.85543	9.84297	[illegible]
$\frac{dz}{d\pi}$	[illegible]	9.83135_n	9.82650_n	9.80992_n	[illegible]
ε	[illegible]	8.81750	8.83814	8.89800	[illegible]
$\frac{dz}{d\delta}$	[illegible]	8.64885	8.66464	[illegible]	[illegible]

	Oct. 12.5	Oct. 16.5	Oct. 20.5	Nov. 1.5	Nov. 17.5
$\frac{dx}{df}$	[illegible]	[illegible]	889065$_n$	[illegible]	0.04498
$\frac{dy}{df}$	0.22995	[illegible]	0.22360	[illegible]	0.19176
$\frac{dz}{df}$	[illegible]	9.83135	9.82650	[illegible]	9.78290
r	0.29060	[illegible]	[illegible]	0.29670	[illegible]
sin u	9.90854	[illegible]	[illegible]	9.86150	[illegible]
r sin u	0.19914	[illegible]	[illegible]	0.15820	[illegible]
cos a	8.59832$_n$	[illegible]	[illegible]	[illegible]	[illegible]
cos b	[illegible]	[illegible]	[illegible]	9.58832$_n$	[illegible]
cos c	9.96426	[illegible]	[illegible]	9.96426	[illegible]
$\frac{dx}{dg}$	[illegible]	[illegible]	[illegible]	8.75652$_n$	[illegible]
$\frac{dy}{dg}$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$\frac{dz}{dg}$	[illegible]	[illegible]	[illegible]	[illegible]	0.08141
x	0.26232	0.25908	0.25553	[illegible]	[illegible]
y	[illegible]	9.80853	[illegible]	[illegible]	9.99888
z	9.51862	9.54281	9.56546	[illegible]	[illegible]
r	0.29060	0.29178	[illegible]	[illegible]	0.30192
$\frac{dx}{dr}$	9.97172	[illegible]	[illegible]	[illegible]	9.92010
$\frac{dy}{dr}$	[illegible]	[illegible]	[illegible]	9.61947	[illegible]
$\frac{dz}{dr}$	[illegible]	[illegible]	9.27248	9.32893	9.38963

	[illegible]	1888 Jan 11.5	[illegible]	[illegible]	March 9.5
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0.32245	[illegible]	0.40652
[illegible]	[illegible]	[illegible]	9.93439	[illegible]	[illegible]
$\frac{\sin a}{t}$	[illegible]	[illegible]	9.38563	[illegible]	9.44800
[illegible]	[illegible]	[illegible]	9.35627	9.37947	[illegible]
$\frac{\sin a}{t}$	[illegible]	[illegible]	9.61191	9.58446	9.43780
[illegible]	[illegible]	[illegible]	[illegible]	9.98716	9.97971
[illegible]	[illegible]	[illegible]	0.32245	0.33866	0.40652
[illegible] $\frac{da}{dx}$	[illegible]	[illegible]	9.38563$_n$	9.39855$_n$	9.44800$_n$
[illegible] $\frac{da}{dy}$	[illegible]	[illegible]	9.61191	9.58446	[illegible]
$\frac{d\delta}{dx}$	9.00830$_n$	[illegible]	8.96818$_n$	8.96393$_n$	8.91299$_n$
$\frac{d\delta}{dy}$	8.40742$_n$	[illegible]	8.74190$_n$	[illegible]	8.92319$_n$
$\frac{d\delta}{dz}$	[illegible]	[illegible]	9.66602	9.64849	9.57319
cot (A+u)	[illegible]	0.11636$_n$	[illegible]	0.27259$_n$	[illegible]
x	[illegible]	0.10446	0.02791	[illegible]	9.85860
cot (B+u)	[illegible]	9.89860	9.77779	9.74465	[illegible]
y	[illegible]	0.18018	[illegible]	0.23786	[illegible]
cot (C+u)	[illegible]	9.79626	[illegible]	9.62168	9.39097
z	[illegible]	[illegible]	9.87873	[illegible]	9.91960

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.07929	0.15018	0.22744	0.23756	0.27305
[illegible]	9.96255	9.96255	9.96255	9.96255	9.96255
x	0.18807	0.10446	0.02791	0.00422	9.88860
sin z	9.59989	9.59989	9.59989	9.59989	9.59989
z	9.75701	9.84009	9.87873	9.88715	9.91960
[illegible]	0.04184	0.14273	0.18099	0.20041	0.24150
z sin z	9.35691	9.43995	9.47862	9.48704	9.51949
[illegible]	0.76648	0.78130	0.78851	0.79018	0.79743
$\frac{dz}{dx}$	0.12339_n	0.22128_n	0.26713_n	0.27722	0.31692_n
[illegible]	0.12285	0.22032	0.26670	0.27681	0.31655
[illegible]	7.09500	7.02500	7.00000	6.97500	6.93000
[illegible]	7.21785_n	7.24582_n	7.26670_n	7.25181_n	7.24655_n
[illegible]	0.15062	0.06701	9.99046	9.78677	9.52115
[illegible]	0.15921_n	0.07878_n	0.00523_n	9.95254_n	9.84386_n
[illegible]	8.30050	8.43900	8.53900	8.56800	8.72990
[illegible]	8.45112_n	8.52601_n	8.54146_n	8.53477_n	8.55128_n
[illegible]	9.78797	9.70435	9.62780	9.60411	9.45849
[illegible]	9.74033_n	9.63635_n	9.53945_n	9.50883_n	9.31057_n
[illegible]	9.06420	9.22914	9.35333	9.38974	9.60831
[illegible]	8.80453	8.86540	8.89275	8.89857	8.91888

	Jan. 0.5	Feb. 0.5	Feb. 3.5	Mar. 0.5	Mar. 0.5
$\frac{dx}{dt}$	0.12285$_n$	[illegible]	[illegible]	0.27681$_n$	[illegible]
$\frac{dy}{dt}$	0.15021	[illegible]	[illegible]	9.98254	[illegible]
$\frac{dz}{dt}$	9.74033	[illegible]	[illegible]	9.50883	[illegible]
r	0.30876	[illegible]	0.32946	0.33160	0.34176
$\sin u$	[illegible]	[illegible]	9.39655	[illegible]	9.50520
$r \sin u$	0.05319	[illegible]	9.72631	9.66860	[illegible]
$\cos a$	8.59832$_n$	[illegible]	8.59859$_n$	8.59859$_n$	[illegible]
$\cos b$	9.58832$_n$	[illegible]	9.58833$_n$	9.58833$_n$	[illegible]
$\cos c$	9.96420	[illegible]	9.96426	9.96426	[illegible]
$\frac{dx}{dt}$	8.65151	[illegible]	8.32490$_n$	8.26719$_n$	[illegible]
$\frac{dy}{dt}$	9.64151$_n$	9.48063$_n$	9.31464$_n$	9.25693$_n$	8.73530$_n$
$\frac{dz}{dt}$	0.01745	9.85656	9.69057	9.63286	[illegible]
x	0.18807	0.10446	0.02791	0.00422	9.85860
y	0.07929	0.18018	0.22744	[illegible]	0.27895
z	9.75701	9.84009	[illegible]	[illegible]	9.91960
r	0.30876	[illegible]	0.32046	0.33160	0.34176
$\frac{x}{r}$	9.87931	[illegible]	9.69847	9.67262	[illegible]
$\frac{y}{r}$	[illegible]	[illegible]	9.89798	9.90626	[illegible]
$\frac{z}{r}$	9.44825	9.51889	9.54927	9.55555	[illegible]

	[illegible]	[illegible]	[illegible]	Nov. 15	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	9.89045	9.91574	[illegible]
[illegible]	[illegible]	[illegible]	8.97957	8.93428	[illegible]
[illegible]	0.30596	[illegible]	0.30596	0.30596	[illegible]
[illegible]	[illegible]	[illegible]	0.02001	0.01807	[illegible]
$\frac{2}{\cos f}$ + tan φ cos f	0.32722	[illegible]	[illegible]	0.32403	0.32132
r^2	0.58120	[illegible]	0.58596	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0.09308	[illegible]	0.07820
$t - T$	1.90037_n	1.87795_n	1.85431_n	1.77452_n	[illegible]
a tan φ sin f	9.39352	9.40358	9.41306	[illegible]	9.46558
[illegible]	5.61545				
r	0.29060	0.29178	[illegible]	[illegible]	0.30192
$2r(206264.8)$	5.90605	5.90723	5.90843	[illegible]	[illegible]
$3u$	3.51414	3.51414	3.51414	3.51414	3.51414
$-\frac{2}{3}\cdot\frac{r}{u}(206264.8)$	[illegible]	2.39309_n	[illegible]	[illegible]	2.40323_n
a tan φ sin f (t − T)	[illegible]	1.28153_n	1.26737_n	[illegible]	[illegible]
ξ	0.03334	0.03236	0.03127	0.02747	0.02662
$\frac{dr}{d\mu}$	[illegible]	2.42545_n	2.42556_n	[illegible]	2.42985_n
$\frac{df}{d\mu}$	[illegible]	1.97343_n	1.94739_n	1.86016_n	1.71369_n
$\frac{dr}{d\varphi}$	[illegible]	[illegible]	0.13600_n	0.09071_n	[illegible]
$\frac{df}{d\varphi}$	0.19813	0.20757	[illegible]	0.23977	[illegible]
$\frac{dr}{dM_0}$	9.39352	9.40358	9.41306	9.43855	9.46558
$\frac{df}{dM_0}$	0.09784	0.09784	0.09548	0.09308	0.08564

	1887. Oct. 12.5	Oct. 16.5	Oct. 20.5	Nov. 1.5.	Nov. 17.5
$\cos\delta \frac{d\alpha}{dx}$	9.51[illegible]	9.49134$_n$	9.46395$_n$	9.37791$_n$	9.28691$_n$
$\frac{dx}{d\pi}$	9.97172	9.96730	9.96255	9.94637	9.92010
$\cos\delta \frac{d\alpha}{dy}$	9.99661	9.99591	9.99330	9.97461	9.92975
$\frac{dy}{d\pi}$	9.48540	9.51675	9.54549	9.61947	9.69696
$\cos\delta \frac{d\alpha}{dx} \cdot \frac{dx}{d\pi}$	9.48839$_n$	9.45864$_n$	9.42610$_n$	9.32428$_n$	9.20701$_n$
$\cos\delta \frac{d\alpha}{dy} \cdot \frac{dy}{d\pi}$	9.48210	9.51266	9.53879	9.59408	9.62671
y	8.16400	9.12208	9.46989	9.63514$_n$	9.21177
$\cos\delta \frac{d\alpha}{d\pi}$	7.64610$_n$	8.58072	0.89639	9.25991	9.41888
$\cos\delta \frac{d\alpha}{dx}$	9.51667$_n$	9.49134$_n$	9.46395$_n$	9.37791$_n$	9.28691$_n$
$\frac{dx}{d\pi}$	9.83116$_n$	9.86207$_n$	9.89065$_n$	9.96520$_n$	0.04498$_n$
$\cos\delta \frac{d\alpha}{dy}$	9.99661	9.99591	9.99330	9.97461	9.92975
$\frac{dy}{d\pi}$	9.78746$_n$	9.78011$_n$	9.77255$_n$	9.74652$_n$	9.70547$_n$
$\cos\delta \frac{d\alpha}{dx} \cdot \frac{dx}{d\pi}$	9.34783	9.35341	9.35460	9.34311	9.33189
$\cos\delta \frac{d\alpha}{dy} \cdot \frac{dy}{d\pi}$	0.22656	0.22282	0.21690	0.18643	0.12151
y	0.05393	0.05503	0.05587	0.05821	0.06532
$\frac{d\alpha}{df}$	0.28049	0.29785	0.27277	0.24464	0.18684
	+1.90760	+1.89602	+1.87400	+1.75650	+1.53759
$\cos\delta \frac{d\alpha}{dx}$	9.51667$_n$	9.49134$_n$	9.46395$_n$	9.37791$_n$	9.28691$_n$
$\frac{dx}{d\delta}$	7.11616$_n$	7.11[illegible]$_n$	7.13565$_n$	7.16020$_n$	7.18498$_n$
$\cos\delta \frac{d\alpha}{dy}$	9.99661	9.99591	9.99330	9.97461	9.92975
$\frac{dy}{d\delta}$	8.29587$_n$	8.30913$_n$	8.32508$_n$	8.36362$_n$	8.40707$_n$

	Oct. 12.5	Oct. 16.5	Oct. [illegible]	Nov. 1.5	Nov. 17.5
$\cos\delta \frac{d\alpha}{dx} \cdot \frac{dx}{dy}$	6.63283	6.60841	[illegible]	[illegible]	6.47189
$\cos\delta \frac{d\alpha}{dy} \cdot \frac{dy}{dx}$	[illegible]	[illegible]	[illegible]	[illegible]	8.33682$_n$
g	1.65003	1.68781	[illegible]	1.79308	1.85896
$\cos\delta \frac{d\alpha}{dx}$	[illegible]	[illegible]	[illegible]	[illegible]	8.33085$_n$
	−0.0195	[illegible]	−0.02042	[illegible]	[illegible]
$\cos\delta \frac{dy}{dx}$	9.99661	9.99591	[illegible]	[illegible]	9.92975
$\frac{dy}{dx}$	[illegible]	9.78011$_n$	[illegible]	9.74652$_n$	9.70547$_n$
$\cos\delta \frac{d\alpha}{dx}$	9.51667$_n$	9.49134$_n$	9.46305$_n$	9.37791$_n$	9.28691$_n$
$\frac{dx}{dx}$	8.79746$_n$	8.79011	8.78235$_n$	8.75652$_n$	8.71547$_n$
$\cos\delta \frac{d\alpha}{dy} \cdot \frac{dy}{dx}$	[illegible]	9.77602$_n$	[illegible]	[illegible]	[illegible]
$\cos\delta \frac{d\alpha}{dy} \cdot \frac{dy}{dx}$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
g	1.45497	1.48043	1.50600	1.57531	0.62260
$\cos\delta \frac{d\alpha}{dx}$	9.76910$_n$	9.76188$_n$	[illegible]	9.70974$_n$	9.62498
	−0.58762	−0.57794	−0.56534	−0.51255	−0.42169
$\frac{d\delta}{dx}$	9.31393$_n$	9.29571$_n$	9.27462$_n$	9.19944$_n$	9.09569$_n$
$\frac{dx}{dr}$	9.97172	9.96730	9.92655	[illegible]	[illegible]
$\frac{d\delta}{dy}$	[illegible]	8.79114$_n$	8.74527$_n$	8.60274$_n$	8.45285$_n$
$\frac{dy}{dr}$	[illegible]	[illegible]	9.54549	9.61947	9.69606
$\frac{d\delta}{dx} \cdot \frac{dx}{dr}$	[illegible]	9.26301$_n$	[illegible]	[illegible]	[illegible]
$\frac{d\delta}{dy} \cdot \frac{dy}{dr}$	8.31948$_n$	8.30789$_n$	[illegible]	8.22221	8.14981$_n$
g	0.04458	0.04567	0.05034	0.04892	0.05543
$\frac{d\delta}{dr}$	9.33023$_n$	9.30868$_n$	[illegible]	9.19473$_n$	9.17122$_n$
$\frac{d\delta}{dz} \cdot \frac{dz}{dr}$	9.23766	9.25842	[illegible]	9.31082	9.32564
g	0.71681				
$\frac{d\delta}{dr}$	8.61342$_n$	8.34713$_n$	[illegible]	[illegible]	[illegible]

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$\cos^2 \frac{dx}{dz}$	[illegible]	9.32864$_n$	9.38563$_n$	9.39855$_n$	9.44800$_n$
$\frac{dx}{dz}$	9.77931	9.78326	9.69845	9.67262	9.51653
$\cos^2 \frac{dy}{dz}$	9.85607	9.71222	9.61191	9.55446	9.43780
$\frac{dy}{dz}$	9.97053	9.85998	9.89995	[illegible]	9.93714
$\cos^2 \frac{dx}{dz} \frac{dx}{dz}$	9.13450$_n$	9.11190$_n$	9.08405$_n$	9.07117$_n$	8.96484$_n$
$\cos^2 \frac{dy}{dz} \frac{dy}{dz}$	9.62660	9.57120	9.50989	9.49072	9.37499
ρ	0.32331	0.27401	0.22160	0.21153	0.19627
$\cos^2 \frac{dz}{dz}$	9.45751	9.35591	9.30568	9.28270	9.16111
$\cos^2 \frac{dx}{dz}$	[illegible]	9.32864$_n$	9.38563$_n$	9.39855$_n$	9.44800$_n$
$\frac{dx}{dz}$	[illegible]	0.22052$_n$	0.26670$_n$	0.27681$_n$	0.31655$_n$
$\cos^2 \frac{dy}{dz}$	[illegible]	9.71222	9.61191	9.55446	9.43780
$\frac{dy}{dz}$	9.64151$_n$	9.48063$_n$	9.31464	9.25693$_n$	8.73530$_n$
$\cos^2 \frac{dz}{dz} \frac{dz}{dz}$	9.37804	9.54946	9.65233	9.67536	9.76455
$\cos^2 \frac{dz}{dz} \frac{dz}{dz}$	0.01525	9.79100	9.11714	9.56700	9.28167
ρ	0.00010	0.19684	0.31547	0.35858	0.60639
$\frac{dz}{dz}$	0.10535	0.95784	9.93612	9.92558	9.88806
	+1.27461	+0.97239	+0.86322	+0.84252	+0.77278
$\cos^2 \frac{dx}{dz}$	9.25519$_n$	9.32864$_n$	9.38563$_n$	9.39858$_n$	9.44800$_n$
$\frac{dx}{dz}$	9.21785$_n$	9.24882$_n$	9.26670$_n$	9.25181$_n$	9.24655$_n$
$\cos^2 \frac{dy}{dz}$	9.85607	9.71222	9.61191	9.55446	9.43780$_n$
$\frac{dy}{dz}$	[illegible]	8.50601$_n$	8.52046$_n$	8.53477$_n$	8.55105$_n$

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
cos ζ	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
sin ζ	[illegible]	9.99304	9.99963	9.99995	9.99529
tan φ cos ζ	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2 : cos φ	[illegible]	[illegible]	[illegible]	[illegible]	0.30596
ν	[illegible]	[illegible]	0.00134	0.00027	1.95493
[illegible]	[illegible]	[illegible]	[illegible]	0.30623	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	0.66320	0.68353
[illegible]	[illegible]	[illegible]	[illegible]	0.01554	9.99551
1 − T	[illegible]	[illegible]	1.53782	1.60746	[illegible]
a tan φ sin ζ	[illegible]	9.51[illegible]	[illegible]	9.52259	9.51790
[illegible]	[illegible]	032120			
[illegible]	[illegible]		0.32046	0.33160	0.34176
[illegible]	[illegible]	[illegible]	5.94491	5.94708	5.95721
[illegible]	[illegible]	3.51414	[illegible]	3.51414	3.51414
[illegible]	[illegible]	2.42251	[illegible]	[illegible]	2.44507
[illegible]	[illegible]	0.57695	1.06006	[illegible]	1.35985
[illegible]	[illegible]	0.00624	0.01885	0.02218	[illegible]
[illegible]	[illegible]	2.41627	2.41102	2.41073	[illegible]
[illegible]	[illegible]	1.09734	[illegible]	[illegible]	[illegible]
[illegible]	1.25605	9.56[illegible]	[illegible]	[illegible]	9.50286
[illegible]	[illegible]	[illegible]	[illegible]	0.30621	0.20645
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9.51790
[illegible]		1.03664	[illegible]	[illegible]	9.99551

	1887 Oct. 12.5	Oct. 16.5	Oct. 20.5	Nov. 1.5	Nov. 17.5
$\cos\delta \frac{dx}{dr}$	7.64610$_n$	8.58072	8.89639	9.25941	9.41878
$\frac{dr}{dq}$	0.16276$_n$	0.14970$_n$	0.13600$_n$	0.09071$_n$	0.01882$_n$
$\cos\delta \frac{dx}{dr}$	0.28049	0.27785	0.27277	0.24464	0.18684
$\frac{dr}{dq}$	0.19813	0.20757	0.21642	0.23977	0.26429
$\cos\delta \frac{dx}{dr} \frac{dr}{dq}$	7.80886	8.73042$_n$	9.03240$_n$	9.35013$_n$	9.43760$_n$
$\cos\delta \frac{dx}{dr} \frac{dr}{dq}$	0.47862	0.48542	0.48919	0.48441	0.45113
ϱ	0.00091	0.00770	0.01844	0.03311	0.04428
$\cos\delta \frac{dx}{dq}$	0.47955	0.47772	0.47375	0.45130	0.40685
	+3.01683	+3.00414	+2.97683	+2.82037	+2.85185
$\frac{d\delta}{dr}$	8.61342$_n$	8.34713$_n$	7.53529$_n$	8.68106	8.97239
$\frac{dr}{dq}$	0.16276$_n$	0.14970$_n$	0.13600$_n$	0.09071$_n$	0.01882$_n$
$\frac{d\delta}{dr}$	9.86004	9.86297	9.86283	9.84512	9.79071
$\frac{dr}{dq}$	0.19813	0.20757	0.21642	0.23977	0.26429
$\frac{d\delta}{dr} \frac{dr}{dq}$	8.77618	8.49683	7.67129	8.77177$_n$	8.99121$_n$
$\frac{d\delta}{dr} \frac{dr}{dq}$	0.05817	0.07054	0.07925	0.08489	0.05502
ϱ	0.02211	0.01144	0.00169	0.02165	0.03920
$\frac{d\delta}{dq}$	0.08029	0.08198	0.08094	0.06324	0.01582
	+1.20308	+1.20775	+1.20486	+1.15676	+1.03709
$\cos\delta \frac{dx}{dr}$	7.64610$_n$	8.58072	8.89630	9.25941	9.41878
$\frac{dr}{dN_c}$	9.39352	9.40358	9.41306	9.43835	9.46558
$\cos\delta \frac{dx}{dr}$	0.28049	0.27785	0.27277	0.24464	0.18684
$\frac{dr}{dN_c}$	0.09784	0.09548	0.09308	0.08564	0.07520
$\cos\delta \frac{dx}{dr} \frac{dr}{dN_c}$	7.03963$_n$	7.98430	8.30945	8.69776	8.88437
$\cos\delta \frac{dx}{dr} \frac{dr}{dN_c}$	0.37833	0.37333	0.36585	0.33028	0.26204
ϱ	0.00020	0.00177	0.00380	0.01000	0.01783
$\cos\delta \frac{dx}{dN_c}$	0.37813	0.37510	0.36065	0.34029	0.27987
	+2.38852	+2.37200	+2.34234	+2.18920	+1.90491

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$\cos^2 \frac{\partial x}{\partial \alpha}$	[illegible]	0.57446	[illegible]	[illegible]	[illegible]
$\cos^2 \frac{\partial x}{\partial \beta}$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$\cos^2 \frac{\partial x}{\partial \gamma}$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$\cos^2 \frac{\partial x}{\partial \delta}$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$\cos^2 \frac{\partial y}{\partial \alpha}$	[illegible]	[illegible]	9.61191	[illegible]	9.43750
$\frac{\partial y}{\partial \beta}$	[illegible]	[illegible]	9.31464	[illegible]	8.73530
$\cos^2 \frac{\partial y}{\partial \gamma}$	9.25510	[illegible]	9.28863	[illegible]	7.44800
$\frac{\partial y}{\partial \delta}$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$\cos^2 \frac{\partial z}{\partial \alpha}$	9.49758	[illegible]	[illegible]	8.54139	[illegible]
$\cos^2 \frac{\partial z}{\partial \beta}$	7.90670	[illegible]	[illegible]	[illegible]	[illegible]
$\frac{\partial z}{\partial \gamma}$	1.37950	1.35452	[illegible]	1.14566	[illegible]
$\cos^2 \frac{\partial z}{\partial \delta}$	9.48629	[illegible]	[illegible]	[illegible]	[illegible]
	-0.30640	[illegible]	[illegible]	[illegible]	[illegible]
$\frac{\partial \alpha}{\partial x}$	9.00830	[illegible]	[illegible]	8.96393	[illegible]
$\frac{\partial \beta}{\partial x}$	9.87931	[illegible]	[illegible]	9.62262	9.51683
$\frac{\partial \gamma}{\partial x}$	8.40742	[illegible]	[illegible]	[illegible]	[illegible]
$\frac{\partial \delta}{\partial x}$	[illegible]	[illegible]	9.89798	9.90626	[illegible]
$\frac{\partial \alpha}{\partial y}$	[illegible]	[illegible]	8.66663	8.63655	[illegible]
$\frac{\partial \beta}{\partial y}$	[illegible]	[illegible]	8.63983	[illegible]	[illegible]
$\frac{\partial \gamma}{\partial y}$	[illegible]	[illegible]	9.28788	[illegible]	[illegible]
$\frac{\partial \delta}{\partial y}$	[illegible]	8.93004	8.05451	8.96211	[illegible]
$\frac{\partial \alpha}{\partial z}$	9.21312	[illegible]	9.21520	9.20405	9.18102
$\frac{\partial \beta}{\partial z}$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$\frac{\partial \gamma}{\partial z}$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$\frac{\partial \delta}{\partial z}$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	8.68106	[illegible]
[illegible]	[illegible]	[illegible]	9.41206	9.43875	9.46[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	9.84512	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	0.08564	[illegible]
[illegible]	[illegible]	[illegible]	6.94875	8.11941	[illegible]
[illegible]	[illegible]	9.95845	9.95591	9.93076	9.86593
[illegible]	[illegible]	[illegible]	[illegible]	0.00665	[illegible]
[illegible]	[illegible]	9.95575	9.95548	9.93741	9.88185
	[illegible]	[illegible]	+0.00256	+0.86578	+0.76182
[illegible]	[illegible]	[illegible]	[illegible]	9.25941	[illegible]
[illegible]	[illegible]	2.42545	[illegible]	2.42548	2.42985
[illegible]	[illegible]	[illegible]	[illegible]	0.24464	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	1.86016	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	1.68459	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	+[illegible]	−[illegible]	−[illegible]	−[illegible]	−150.010
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	2.42548	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	9.84512	[illegible]
[illegible]	[illegible]	[illegible]	1.94739	1.86016	[illegible]
[illegible]	[illegible]	[illegible]	9.96085	[illegible]	1.40224
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	150442
[illegible]	[illegible]	[illegible]	0.00626	[illegible]	[illegible]
[illegible]	1.78690	[illegible]	[illegible]	1.80306	[illegible]
	−61.2214	[illegible]	−63.6[illegible]	−63.5414	[illegible]

	Dec. 7c	Jan. 16	Feb. 2.5	Feb. 9.5	Mar. 9.5
$\cos^2 \frac{d\alpha}{d\varphi}$	9.45781	9.38591	9.30568	9.28270	9.16111
$\cos \frac{d\alpha}{d\varphi}$	9.99383$_n$	9.56731	8.95004$_n$	8.24553$_n$	9.50286
$\cos^2 \frac{d\delta}{d\varphi}$	9.10223	9.98784	9.93612	9.92555	9.88806
$\cos \frac{d\delta}{d\varphi}$	9.99605	9.30510	9.30693	9.30621	9.29645
$\cos \frac{d\alpha}{d\varphi} \cos \frac{d\delta}{d\varphi}$	9.36164$_n$	8.88322$_n$	8.23664$_n$	7.53755$_n$	8.66297
$\frac{1}{\Delta} \frac{d\alpha}{d\varphi} \frac{d\delta}{d\varphi}$	9.29143	9.29294	0.24305	0.23170	0.18451
$\frac{1}{\Delta}$	9.04227	9.00232	0.00450	0.00086	0.01290
$\cos \frac{\alpha}{2}$	9.24886	9.27261	0.23855	0.23093	0.19742
	+1.22287	+1.87220	+1.73200	+1.70190	+1.57550
$\frac{1}{\Delta}$	9.00457	8.81182	8.86094	8.53455	8.62511
$\frac{1}{\Delta} \cos \frac{d\alpha}{d\varphi}$	9.00283$_n$	9.56731$_n$	8.95004$_n$	8.24853$_n$	9.50286
$\frac{1}{\Delta} \cos^2 \frac{d\delta}{d\varphi}$	9.10210	9.54050	9.44150	9.41216	9.27341
$\frac{1}{\Delta} \cos \frac{d\delta}{d\varphi}$	2.8605	0.26510	0.26602	0.26621	0.20645
$\frac{1}{\Delta} \cos \frac{d\alpha}{d\varphi} \cos \frac{d\delta}{d\varphi}$	8.05840$_n$	8.34910$_n$	7.82088$_n$	7.08008$_n$	8.12707
$\frac{1}{\Delta} \frac{d\alpha}{d\varphi} \frac{d\delta}{d\varphi}$	9.98616	9.84560	9.74840	9.71127	9.56956
$\frac{1}{\Delta}$	0.04278	0.00251	0.00516	0.00099	0.01542
$\cos \frac{\alpha}{2}$	9.94338	9.83312	9.74327	9.72028	9.55328
	+0.57776	+0.66547	+0.55370	+0.52527	+0.38484
$\cos^2 \frac{\alpha}{2}$	9.45781	9.32501	9.30568	9.28270	9.16111
$\cos^2 \frac{\alpha}{2} \cos^2 \frac{d\alpha}{d\varphi}$	9.40086	9.51625	9.52224	9.52259	9.51790
$\cos^2 \frac{\alpha}{2} \cos^2 \frac{d\delta}{d\varphi}$	9.10528	9.09784	9.93612	9.92558	9.88806
$\cos^2 \frac{\alpha}{2} \cos \frac{d\alpha}{d\varphi} \cos \frac{d\delta}{d\varphi}$	8.46152	8.02661	0.02012	0.01584	9.99551
$\cos^2 \frac{\alpha}{2} \frac{1}{\Delta} \frac{d\alpha}{d\varphi} \frac{d\delta}{d\varphi}$	8.04867	8.90216	8.82701	8.80529	8.67901
$\cos^2 \frac{\alpha}{2} \frac{1}{\Delta}$	9.16600	0.02448	9.95624	9.94142	9.88357
$\cos^2 \frac{\alpha}{2}$	9.12257	0.03159	0.03117	0.03064	0.02630
$\cos^2 \frac{\alpha}{2}$	9.10247	9.02607	9.95741	9.97206	9.90957
	+1.55764	+1.13778	+0.97142	+0.93770	+0.81258

	[illegible]	1888 Jan 11.5	[illegible]	[illegible]	Mar 9.5
$\frac{d\delta}{dr}$	9.05457	8.98182	8.86994	8.83455	8.62511
$\frac{dr}{dM_0}$	9.49086	9.51625	9.52224	9.52239	9.51790
$\frac{d\delta}{df}$	9.70010	9.54059	9.44150	9.41516	9.27341
$\frac{df}{dM_0}$	0.00152	0.03664	0.02012	0.01584	9.99551
$\frac{d\delta}{dr}\cdot\frac{dr}{dM_0}$	8.54543	8.49807	8.39218	0.35714	8.14301
$\frac{d\delta}{df}\cdot\frac{df}{dM_0}$	9.76162	9.57723	9.46162	9.43100	9.26892
ρ	0.02563	0.03476	0.03552	0.03517	0.03134
$\frac{d\delta}{dM_0}$	9.78725	9.61199	9.49714	9.46617	9.30026
	+0.61270	+0.40925	+0.31415	+0.29253	+0.19965
$\cos\delta\frac{d\alpha}{dr}$	9.45781	9.38591	9.30568	9.28270	9.16111
$\frac{dr}{d\mu}$	2.42219$_n$	2.41627$_n$	2.41192$_n$	2.41073$_n$	2.40565$_n$
$\cos\delta\frac{d\alpha}{df}$	0.10538	9.98784	9.93612	9.92558	9.88806
$\frac{df}{d\mu}$	1.43259$_n$	1.09734	1.55794	1.62330	1.83749
$\cos\delta\frac{d\alpha}{dr}\cdot\frac{dr}{d\mu}$	1.88000$_n$	1.80218$_n$	1.71760$_n$	1.69343$_n$	1.56676$_n$
$\cos\delta\frac{d\alpha}{df}\cdot\frac{df}{d\mu}$	1.53797$_n$	1.05118	1.49406	1.54888	1.72555
ρ	0.16285	0.09252	0.39541	0.54804	0.51391
$\cos\delta\frac{d\alpha}{d\mu}$	2.04285$_n$	1.70966$_n$	1.32228$_n$	1.14539$_n$	1.21165
	−110.370	−51.2462	−21.0030	−13.9761	+16.2794
$\frac{d\delta}{dr}$	9.05457	8.98182	8.86994	8.83455	8.62511
$\frac{dr}{d\mu}$	2.42219$_n$	2.41627$_n$	2.41192$_n$	2.41073	2.40565$_n$
$\frac{d\delta}{df}$	9.70010	9.54059	9.44150	9.41516	9.27341
$\frac{df}{d\mu}$	1.43259$_n$	1.09734	1.55794	1.62330	1.83749
$\frac{d\delta}{dr}\cdot\frac{dr}{d\mu}$	1.47676$_n$	1.39809$_n$	1.28186$_n$	1.24528$_n$	1.03076$_n$
$\frac{d\delta}{df}\cdot\frac{df}{d\mu}$	1.13269$_n$	0.63793	0.99944	1.03846	1.11090
ρ	0.16221	0.08287	0.32047	0.42150	0.77339
$\frac{d\delta}{d\mu}$	1.63897$_n$	1.31522$_n$	0.96139$_n$	0.82377$_n$	0.33751
	−43.548	−20.6646	−9.14940	−6.6648	+2.17525

	[illegible]	[illegible]	[illegible]	Nov. 1.5	Nov. 17.5
[illegible]	9.31393$_n$	[illegible]	[illegible]	[illegible]	9.09565$_n$
[illegible]	9.83116$_n$	9.86207$_n$	9.89065$_n$	[illegible]	[illegible]
[illegible]	9.14509	[illegible]	9.16527	9.16464	[illegible]
[illegible]	8.83399$_n$	8.79114$_n$	8.74527$_n$	8.60274$_n$	8.45285$_n$
[illegible]	0.22995	[illegible]	0.22360	0.21182	[illegible]
[illegible]	9.06394$_n$	[illegible]	[illegible]	8.81456$_n$	8.64461$_n$
[illegible]	0.00964	0.00739	0.00340	[illegible]	9.93601
[illegible]	9.83559	[illegible]	9.82650	9.80992	9.78290
[illegible] = ([illegible])	9.84553	[illegible]	9.82990	9.79182	9.71591
[illegible]	[illegible]	9.29571$_n$	9.27462$_n$	9.19944$_n$	9.09569$_n$
[illegible]	7.11616$_n$	7.11707$_n$	7.13565$_n$	[illegible]	7.18498$_n$
[illegible]	6.43009	6.41278	[illegible]	[illegible]	6.28067
[illegible]	8.83399$_n$	8.79114$_n$	8.74527$_n$	[illegible]	[illegible]
[illegible]	8.29587$_n$	8.30913$_n$	8.32508$_n$	8.36362$_n$	[illegible]
[illegible]	7.12986	7.10027	[illegible]	6.96636	6.85992
[illegible]	0.00964	0.00739	0.00340	9.98189	9.93601
[illegible]	8.63172	8.64885	8.66464	8.70792	[illegible]
[illegible] = ([illegible])	[illegible]	8.65624	8.66804	8.68981	[illegible]
[illegible]	9.31393$_n$	9.29571$_n$	9.27462$_n$	9.19944$_n$	[illegible]
[illegible]	[illegible]	8.79011$_n$	8.78235$_n$	8.75652$_n$	8.71547$_n$
[illegible]	8.11139	8.08582	8.05697	7.95596	[illegible]
[illegible]	8.83399$_n$	8.79114$_n$	8.74527$_n$	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	8.62145	[illegible]	[illegible]	8.34026	[illegible]
[illegible]	0.00964	[illegible]	[illegible]	9.98189	[illegible]
[illegible]	0.16340	0.15605	[illegible]	0.12246	[illegible]
[illegible] ([illegible])	[illegible]	[illegible]	[illegible]	0.10435	[illegible]

	Oct. 12.5	Oct. 16.5	Oct. 20.5	Nov. 1.5	[illegible]
$\frac{d\delta}{dx}\cdot\frac{dx}{d\pi}$	+0.13066	+0.14381	+0.14631	+0.14610	+0.13825
$\frac{d\delta}{dy}\cdot\frac{dy}{d\pi}$	−0.11586	−0.10424	−0.09308	−0.06525	−0.04411
$\frac{d\delta}{dz}\cdot\frac{dz}{d\pi}$	+0.7[illegible]	+0.6[illegible]	+0.67593	+0.61918	+0.52349
$\frac{d\delta}{d\pi}$	+0.7[illegible]450	+0.72939	+0.72916	+0.7[illegible]	+0.61763
log	9.86004	+9.86297	9.86283	[illegible]	[illegible]
$\frac{d\delta}{dx}\cdot\frac{dx}{d\delta}$	+0.00027	+0.00026	+0.00026	+0.00022	+0.00019
$\frac{d\delta}{dy}\cdot\frac{dy}{d\delta}$	+0.00135	+0.00126	+0.00118	+0.00093	+0.00072
$\frac{d\delta}{dz}\cdot\frac{dz}{d\delta}$	+0.04379	+0.04532	+0.04656	+0.04896	+0.04921
$\frac{d\delta}{d\delta}$	+0.04541	+0.04684	+0.04800	+0.05012	+0.05012
$\frac{d\delta}{dx}\cdot\frac{dx}{di}$	−0.01292	+0.01215	+0.01140	+0.00903	+0.00647
$\frac{d\delta}{dy}\cdot\frac{dy}{di}$	+0.04182	+0.03726	+0.03293	+0.02235	+0.01440
$\frac{d\delta}{dz}\cdot\frac{dz}{di}$	+1.48950	+1.45693	+1.41805	+1.27160	+1.04093
$\frac{d\delta}{d\delta}$	+1.54425	+1.50638	+1.46238	+1.30298	+1.06180

	Cos.	Sin.	Tan.	Cot.	Sec.	Cosec.
$\frac{d^2}{dx^2}$	8.00830n	8.97354n	8.96818n	8.96393n	8.97120n	8.97120n
$\frac{d^2}{dx^2} : \frac{dx}{dz}$	0.65151n	8.40080n	8.32490n	8.26710n	7.74556n	0.31655n
$\frac{d^2}{dx^2} : \frac{dx}{dz}$	7.65951	7.46443	7.26505	7.26511	6.65855	6.22054
$\frac{d^2}{dx^2} : \frac{dz}{dx}$	8.40742n	8.58096n	8.74190n	8.77802n	8.97231n	8.97231n
$\frac{d^2}{dx^2} : \frac{dz}{dx}$	0.15951	0.97555	0.00523	9.98254	9.53186	9.53186
$\frac{d^2}{dy^2} : \frac{dz}{dx}$	8.56663n	8.68874n	8.74713n	8.76056n	8.76705n	8.76705n
$\frac{d^2}{dz^2} : \frac{dz}{dx}$	9.86455	9.73913	9.66602	9.64840	9.57310	9.57310
$\frac{d^2}{dz^2} : \frac{dz}{dx}$	9.74633	9.63635	9.52945	9.50883	9.21057	9.21057
$\frac{d^2}{dz^2} : \frac{dz}{dx} : \frac{dz}{dx}$	0.60821	9.37548	9.20547	9.15732	8.88576	8.88576
$\frac{d^2}{dz^2}$	9.00830n	8.97354n	8.96818n	8.96393n	8.97120n	8.97120n
$\frac{d^2}{dz^2} : \frac{dz}{dx}$	7.21785n	7.45555n	7.26670n	7.25181n	7.46655n	7.46655n
$\frac{d^2}{dz^2} : \frac{dz}{dx}$	6.22615	6.21936	6.23488	6.21574	6.15954	6.15954
$\frac{d^2}{dz^2} : \frac{dz}{dx} : \frac{dz}{dx}$	8.40742n	8.58096n	8.74190n	8.77802n	8.97231n	8.97231n
$\frac{d^2}{dz^2} : \frac{dz}{dx} : \frac{dz}{dx}$	8.42111n	8.50601n	8.72046n	8.74777n	8.55105n	8.55105n
$\frac{d^2}{dz^2} : \frac{dz}{dx}$	0.85854	9.00507	7.57136	7.31279	7.47424	7.47424
$\frac{d^2}{dz^2} : \frac{dz}{dx}$	9.86455	9.73913	9.66602	9.64840	9.57319	9.57319
$\frac{d^2}{dz^2} : \frac{dz}{dx} : \frac{dz}{dx}$	8.80453	8.86540	8.59[illegible]	8.50957	8.01855	8.01855
$\frac{d^2}{dz^2} : \frac{dz}{dx} : \frac{dz}{dx} : \frac{dz}{dx}$	8.66041	8.60462	8.55856	8.54706	8.40207	8.40207
$\frac{d^2}{dz^2}$	9.00830n	8.97354n	8.96818n	8.96393n	8.97129n	8.97129n
$\frac{d^2}{dz^2} : \frac{dz}{dx}$	8.65151n	8.40080n	8.32490n	8.26710n	7.74556n	7.74556n
$\frac{d^2}{dz^2} : \frac{dz}{dx}$	7.65951	7.46443	7.26505	7.26511	6.65855	6.65855
$\frac{d^2}{dz^2} : \frac{dz}{dx} : \frac{dz}{dx}$	8.40742n	8.58096n	8.74190n	8.77802n	8.97231n	8.97231n
$\frac{d^2}{dz^2} : \frac{dz}{dx} : \frac{dz}{dx}$	9.01151n	9.48066n	9.01146n	9.06935n	8.55[illegible]n	8.55[illegible]n
$\frac{d^2}{dz^2} : \frac{dz}{dx} : \frac{dz}{dx} : \frac{dz}{dx}$	8.04843	8.07059	8.05654	8.02435	7.65849	7.65849
$\frac{d^2}{dz^2} : \frac{dz}{dx} : \frac{dz}{dx} : \frac{dz}{dx} : \frac{dz}{dx}$	9.86455	9.73913	9.66602	9.64840	9.57319	9.57319
$\frac{d^2}{dz^2} : \frac{dz}{dx} : \frac{dz}{dx} : \frac{dz}{dx} : \frac{dz}{dx} : \frac{dz}{dx}$	0.01745	9.85656	9.69057	9.63286	9.11123	9.11123
$\frac{d^2}{dz^2} : \frac{dz}{dx} : \frac{dz}{dx} : \frac{dz}{dx} : \frac{dz}{dx} : \frac{dz}{dx} : \frac{dz}{dx}$	9.88233	9.50969	9.35659	9.28135	8.03442	8.03442

	[illegible]	1888 Jan 11.5	[illegible]	[illegible]	Mar. 9.5
$\frac{d\lambda}{d\pi}$	+[illegible]	+0.15644	+0.17174	+0.17407	+0.16964
$\frac{d\lambda}{d\pi}\cdot\frac{d\theta}{d\pi}$	−[illegible]	−0.04664	−0.05586	−0.05762	−0.05848
$\frac{d\lambda}{d\pi}\cdot\frac{d\pi}{d\pi}$	+0.40291	+0.23740	+0.16049	+0.14365	+0.07652
$\frac{d\lambda}{d\pi}$	−[illegible]	+0.34720	+0.27637	+0.26011	+0.18768
$\log$	9.70010	9.54059	9.44150	9.41516	9.27341
$\frac{d\lambda}{d\Omega}$	+0.00017	+0.00017	+0.00017	+0.00016	+0.00014
$\frac{d\lambda}{d\Omega}\cdot\frac{d\theta}{d\Omega}$	+0.00072	+0.00125	+0.00187	+0.00206	+0.00298
$\frac{d\lambda}{d\Omega}\cdot\frac{d\pi}{d\Omega}$	+0.04671	+0.04024	+0.03621	+0.03524	+0.03105
$\frac{d\lambda}{d\Omega}$	+0.04760	+0.04166	+0.03825	+0.03746	+0.03417
$\frac{d\lambda}{d\Omega}$	+0.00457	+0.00291	+0.00196	+0.00170	+0.00045
$\frac{d\lambda}{d\Omega}\cdot\frac{d\theta}{d\Omega}$	+0.01119	+0.01176	+0.01139	+0.01084	+0.00455
$\frac{d\lambda}{d\Omega}\cdot\frac{d\pi}{d\Omega}$	+0.76267	+0.39418	+0.22729	+0.19114	+0.04835
$\frac{d\lambda}{d\Omega}$	+0.77883	+0.40886	+0.24065	+0.20368	+0.05336

We now find the following differential equations of condition in which the co-efficients are expressed in logarithms: –

[illegible]	0.28049 $\Delta\pi$	8.28286$_n$ $\Delta\Omega$	9.76910$_n$ Δi	0.47955 $\Delta\varphi$	[illegible] ΔM_0	2.27600$_n$ $\Delta\mu$	= 0
[illegible]	0.27755	8.29622$_n$	[illegible]	[illegible]	[illegible]	2.27530$_n$	
[illegible]	0.27277	[illegible]	9.75231$_n$	0.47375	0.36965	[illegible]	
[illegible]	[illegible]	[illegible]	9.76974$_n$	0.45130	[illegible]	[illegible]	
[illegible]	0.18684	[illegible]	9.62498$_n$	[illegible]	[illegible]	2.17638$_n$	

[illegible]	0.10538 $\Delta\pi$	[illegible] $\Delta\Omega$	9.48629$_n$ Δi	0.34886 $\Delta\varphi$	0.19247 ΔM_0	2.04285$_n$ $\Delta\mu$	= 0
[illegible]	[illegible]	[illegible]	9.17406$_n$	[illegible]	0.05607	1.70966$_n$	
[illegible]	[illegible]	[illegible]	8.89931$_n$	0.23855	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	8.81140$_n$	[illegible]	9.97206	1.14539$_n$	
March 9.5	9.88506	9.66621$_n$	8.12501$_n$	0.19742	9.90987	1.24163$_n$	

$\Delta\delta$

1887 Oct. 12.5	9.86004 $\Delta\pi$	8.65715$_n$ $\Delta\Omega$	0.18871 Δi	0.08029 $\Delta\varphi$	9.95299 ΔM_0	1.78690$_n$ $\Delta\mu$	= [illegible]
16.5	9.80447	8.67062	[illegible]	[illegible]	[illegible]	[illegible]	
" 20.5	9.86283	8.68124	0.16506	0.08094	9.95548	1.80396$_n$	
[illegible] 15	9.44512	8.70001	0.11494	0.06324	9.93741	1.80206$_n$	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

1887 Dec. 7.5	9.70010 $\Delta\pi$	8.67761 $\Delta\Omega$	9.80122 Δi	9.94338 $\Delta\varphi$	9.79725 ΔM_0	1.63897$_n$ $\Delta\mu$	= 0
1888 Jan. 11.5	9.54059	8.61972	9.61157	9.82313	9.61199	1.31522$_n$	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
" 0.5	9.41516	8.57357	9.20895	9.72038	9.46617	0.83377$_n$	
Mar. 0.5	9.27341	8.53364	8.72722	9.58525	9.20026	0.32751$_n$	

Substituting in these differential equations the residuals already found and expressing the differential coefficients in numbers we have the following equations of condition from which to find the normal equations

1887 Oct. [illegible]	+1.90760 Δπ	−0.01918 Δω	−0.58762 Δi	+[illegible] Δφ	+[illegible] ΔM	−188.800 Δμ	= +0.60	
16.[illegible]	+1.[illegible]	−0.01978	−0.57794	+3.00414	+2.37[illegible]	−188.40[illegible]	= +1.97	[illegible]
20.5	+1.87402	−0.02142	−0.56534	+2.97680	+2.34234	−187.01[illegible]	= +1.20	6
[illegible]	+1.[illegible]650	−0.02144	−0.51255	+2.82690	+2.18920	−175.704	= [illegible]	[illegible]
17.5	+1.[illegible]	−0.02142	−0.42169	+2.55185	+1.90491	−150.100	= +1.[illegible]	3
Dec. 7.5	+1.27461 Δπ	−0.01999 Δω	−0.30640 Δi	+2.[illegible] Δφ	+1.55764 ΔM	−110.370 Δμ	= +1.[illegible]	
1888 Jan. 11.5	+0.97239	−0.01615	−0.14930	+1.87326	+1.13778	−51.246	= +2.[illegible]	4
Feb. 3.5	+0.86322	−0.01340	−0.07930	+1.7[illegible]	+0.97142	−21.003	= −0.[illegible]	
[illegible]	+0.84252	−0.01271	−0.06477	+1.70190	+0.93770	−13.076	= +0.[illegible]	[illegible]
Mar. 9.5	+0.77278	−0.00926	−0.01334	+1.57550	+0.81258	+16.279	= −0.15	1
1887 Oct. 12.5	+0.72450 Δπ	+0.04541 Δω	+1.54425 Δi	+1.20308 Δφ	+0.89740 ΔM₀	−61.221 Δμ	= +0.99	10
16.5	+0.72939	+0.04684	+1.50638	+1.20775	+0.90312	−62.690	= +1.[illegible]	[illegible]
[illegible]	+0.72916	+0.04800	+1.46238	+1.20486	+0.90256	−63.67[illegible]	= +0.90	[illegible]
[illegible]	+0.70003	+0.05012	+1.30298	+1.15676	+0.86578	−63.541	= +1.27	7
[illegible]	+0.61763	+0.05012	+1.06180	+1.03709	+0.76182	+57.192	= +0.23	4
1887 Dec. 7.5	+0.50130 Δπ	+0.04760 Δω	+0.77842 Δi	+0.87776 Δφ	+0.61270 ΔM₀	−43.548 Δμ	= [illegible]	5
[illegible] 11	+0.34720	+0.04166	+0.40886	+0.66547	+0.40925	−20.664	= [illegible]	4
[illegible]	+0.27637	+0.03825	+0.24065	+0.55370	+0.31415	−9.149	= −1.70	[illegible]
[illegible].5	+0.26011	+0.03746	+0.20368	+0.52527	+0.29253	−6.664	= −1.2[illegible]	[illegible]
Mar. 9.5	+0.18768	+0.03417	+0.05336	+0.[illegible]	+0.19965	−2.175	= −2.00	1

In order to have these equations of condition more symmetrical and of a simpler form for calculation we make the following transformations in accordance with the equations

$$k\,\Delta M' = k\,\Delta M - h\,\Delta u$$

$$\Delta M' = \Delta M + \frac{h}{k}\,\Delta u$$

$$k\,\Delta \Omega' = k\,\Delta i - h\,\Delta \Omega$$

$$\Delta \Omega' = \Delta \Omega + \frac{h}{k}\,\Delta i$$

etc. etc.;

but

$$0.42169\,u = 0.42169\,\Delta i + 0.02142\,\Delta \Omega$$

$$u = \Delta i + [8.70583]\,\Delta \Omega$$

$$\Delta i = u - [8.70583]\,\Delta \Omega\,;$$

also

$$1.90491\,t = 1.90491\,\Delta M_0 + 2.55185\,\Delta \varphi + 1.53759\,\Delta \pi - 150.010\,\Delta u$$

$$t = \Delta M_0 + [0.12698]\,\Delta \varphi + [9.90697]\,\Delta \pi - [1.89651]\,\Delta u$$

$$\Delta M_0 = t - [0.12698]\,\Delta \varphi - [9.90697]\,\Delta \pi + [1.89651]\,\Delta u$$

etc. etc.

which will give the following transformed equations:

								n
+ 2.38852	− 0.18294 Δq	− 0.02040 Δπ	− 0.583 Δu	− 0.58762 u	+ 0.01067 ΔR	= + 0.60		9
+ 2.37200	− 0.17332	− 0.01852	− 1.505	− 0.57704	+ 0.00955	= + 1.97		7
+ 2.34234	− 0.16116	− 0.01674	− 2.445	− 0.56534	+ 0.00830	= + 1.20		6
+ 2.18920	− 0.10583	− 0.01058	− 2.199	− 0.51225	+ 0.00460	= + 3.30		6
+ 1.90491	0.00000	− 0.00000	0.000	− 0.42169	0.00000	= + 1.91		3
+ 1.55764	+ 0.14621 Δq	+ 0.01731 Δπ	+ 12.369 Δu	− 0.30640 u	− 0.00443 ΔR	= + 1.76		5
− 1.13778	+ 0.34902	+ 0.05397	+ 38.410	− 0.14930	− 0.00857	= + 2.35		4
+ 0.97142	+ 0.43067	+ 0.07910	+ 55.542	− 0.07930	− 0.00937	= − 0.75		2
− 0.93770	+ 0.44576	+ 0.08564	+ 50.510	− 0.06478	− 0.00942	= + 0.94		3
+ 0.81258	+ 0.48700	+ 0.11685	+ 80.309	− 0.01334	− 0.00858	= − 0.15		1
− 0.50701	+ 0.00089 Δq	+ 0.00013 Δπ	+ 9.492 Δu	+ 1.54425 u	− 0.03303 ΔR	= + 0.93		10
+ 0.90312	− 0.00205	+ 0.00040	+ 8.473	+ 1.50638	− 0.02968	= + 1.20		9
+ 0.90256	− 0.00422	+ 0.00063	+ 7.446	+ 1.46235	− 0.02625	= + 0.90		8
+ 0.86578	− 0.00310	+ 0.00119	+ 4.680	+ 1.30209	− 0.01607	= + 1.27		7
+ 0.76152	+ 0.01656	+ 0.00270	+ 2.436	+ 1.06180	− 0.00369	= + 0.23		4
+ 0.61201	+ 0.05608 Δq	+ 0.00674 Δπ	+ 4.731 Δu	+ 0.77543 u	+ 0.00507 ΔR	= + 0.26		5
+ 0.41741	+ 0.11723	+ 0.01686	+ 11.583	+ 0.40886	+ 0.02089	= + 0.75		4
[illegible]	+ 0.13286	+ 0.02270	+ 15.605	+ 0.24065	+ 0.02603	= + 1.70		2
+ 0.29253	+ 0.13340	+ 0.02309	+ 16.385	+ 0.20368	+ 0.02711	= − 1.73		3
+ 0.19965	+ 0.11730	+ 0.02653	+ 17.907	+ 0.05336	+ 0.03146	= − 2.60		1

Substituting in these equations

$x = \Delta q : 10$; $y = \Delta\pi : 100$ $z = 10\,\Delta u$ $u = \Delta R : 100$, we get the following simplified forms of the equations for solution:

+ 2.39 t	− 1.83 x	− 2.04 y	− 0.06 z	− 0.59 u	+ 1.07 w	= + 0.60	9
+ 2.37	− 1.73	− 1.85	− 0.16	− 0.55	+ 0.96	= + 1.97	7
+ [illegible]	− 1.61	− 1.67	− 0.24	− 0.57	+ [illegible]	= + 1.[illegible]	6
+ [illegible]	− 1.06	− 1.06	− [illegible]	− 0.51	+ [illegible]	+ [illegible]	6
+ 1.91				− 0.42		= + 1.91	3
+ 1.54 t	+ 1.46 x	+ 1.73 y	+ 1.24 z	− 0.31 u	− 0.44 w	= + 1.76	5
+ 1.14	+ 3.49	+ 5.46	+ 3.84	− 0.15	− 0.86	= + 2.85	4
+ 0.97	+ 4.31	+ 7.91	+ 5.55	− 0.08	− 0.94	= − 0.75	2
+ 0.94	+ 4.46	+ 8.56	+ 5.98	− 0.06	− 0.94	= + 0.94	3
+ 0.81	+ 4.57	+ 11.69	+ 8.03	− 0.01	− 0.86	= − 0.15	1
+ [illegible]	+ [illegible]	+ [illegible]	+ [illegible]	+ 1.54 u	− [illegible]	= + [illegible]	10
− [illegible]	+ 0.02	+ 0.04	+ 0.85	+ 1.51	− 2.97	= + 1.20	9
− [illegible]	+ [illegible]	+ [illegible]	+ 0.74	+ 1.46	− 2.63	= + 0.90	8
+ [illegible]	+ [illegible]	+ [illegible]	+ 0.47	+ 1.30	− 1.61	= + 1.27	7
+ [illegible]	+ [illegible]	+ [illegible]	+ 0.28	+ 1.06	− 0.37	= + 0.23	4
− [illegible]	+ [illegible]	+ [illegible]	+ 0.47 z	+ 0.78 u	+ 0.81 w	= + 0.81	5
+ [illegible]	+ 1.17	+ 1.69	+ 1.16	+ 0.41	+ 2.09	= + 2.09	4
− [illegible]	+ 1.33	− [illegible]	+ 1.56	+ 0.24	+ [illegible]	= + [illegible]	[illegible]
+ [illegible]	+ 1.33	+ [illegible]	+ 1.64	+ 0.20	+ 2.71	= + 2.71	3
+ [illegible]	+ 1.17	+ [illegible]	+ 1.79	+ 0.05	+ 3.15	= + 3.15	1

Part Third

Special Perturbations of (Ze) by Jupiter

Thus far we have proceeded to determine the elements of the planet as they would be if the motion were undisturbed. But a complete determination of the orbit requires the consideration of any [illegible] that may be produced in the planet's motion by a disturbing force. Owing to their relative positions, it becomes necessary to take into account the perturbations arising from the disturbing influence of Jupiter.

Thus before applying the values which we have obtained, $\Delta\alpha$ and $\Delta\delta$ by substituting them in [illegible] condition and solving to determine the change they produce upon the values of the elements, we will first compute the perturbations by Jupiter directly for the elements.

Then combining the perturbations [illegible] result in the equations of condition and solving to find the corrections, they will give the final elements.

[illegible] values which represent the disturbing force of the planet Jupiter for every forty days. These values can then be found for the times for which the equations of condition are found by numerical integration.

The numerical values of the constants which we have occasion to use are already known from the preceding investigation.

The formulae used in the computation of the perturbations are as follows:

Section XVI.

$$a^{3/2} = \frac{k''}{\mu} \quad ; \qquad \log k'' = 3.550007$$

$$e'' = \frac{\sin\varphi}{\sin\iota} \qquad \log \frac{1}{\sin\iota} = 5.314425$$

$$M = L - \pi$$

$$E'' - e\sin E'' = M$$

$$r\sin v = a\cos\varphi\sin E$$

$$r\cos v = a(\cos E - \sin\varphi)$$

$$\omega = \pi - \Omega$$

$$u = v + \omega$$

$$p = a\cos^2\varphi$$

$$\{i : W\} = r\cos u$$

$$\{\Omega : W\} = \frac{r\sin u}{\sin\iota}$$

$$\{\mu : R\} = -\frac{3k\mu}{\sqrt{a}}\sin\varphi\sin v \; ; \qquad w = 40.$$

$$\{\mu : S\} = -\frac{3k\mu}{\sqrt{a}}\cdot\frac{p}{r}$$

$$\{L : R\} = [illegible]$$

$$\{L : S\} = (p + r)\sin v\tan\tfrac{1}{2}\varphi$$

$$\{L : W\} = r\sin u\tan\tfrac{1}{2}i$$

$$\{\pi : R\} = -\frac{p}{\sin\varphi}\cos v$$

$$\{\pi \cdot \delta\} = [illegible]$$

$$\{\varphi \cdot \alpha\} = a \cos\varphi \sin f$$

$$\{\varphi \cdot \delta\} = a \cos\varphi \left[\cos f + \cos E\right].$$

[illegible]

[illegible] distance [illegible]

[illegible] the mass [illegible] disturbing planet.

$$q \sin G = \sin \beta_0'$$

$$q \cos G = \cos \beta_0 \sin (\lambda_0' - \Omega)$$

$$\cos B_1 \cos L_1 = \cos \beta_0' \cos (\lambda_0' - \Omega)$$

$$\cos B_1 \sin L_1 = q \cos (G - i)$$

$$\sin B_1 = q \sin (G - i)$$

$$\xi_1 = r_1 \cos B_1 \cos (L_1 - u)$$

$$\eta_1 = r_1 \cos B_1 \sin (L_1 - u)$$

$$\zeta = r_1 \sin B_1$$

$$\rho \cos\vartheta \cos\Theta = \xi_1 - \eta_1$$

$$\rho \cos\vartheta \sin\Theta = \eta_1$$

$$\rho \sin\vartheta = \zeta_1$$

$$K = \frac{1}{\xi} - \frac{1}{\eta_1}$$

$$A_0 = K\xi_1 - \frac{\rho}{\xi}$$

$$S_0 = K\eta_1$$

$$W_0 = K\zeta_1$$

$$R = \left(\frac{m_1 \sqrt{m_1}}{\sqrt{\rho}}\right) R_0$$

$$S = \left(\frac{m_1 \sqrt{m_1}}{\sqrt{\rho}}\right) S_0$$

$$W = \left(\frac{m_1 \sqrt{m_1}}{\sqrt{\rho}}\right) W_0$$

$$\Delta i = \{i : W\}W$$

$$\Delta \Omega = \{\Omega : W\}W$$

$$w\,\Delta \mu = \{\mu : R\}R + \{\mu : S\}S$$

$$\Delta L_1 = \{L : R\}R + \{L : S\}S + \{L : W\}W$$

$$\Delta \pi = \{\pi : R\}R + \{\pi : S\}S + \{L : W\}W$$

$$\Delta \varphi = \{\varphi : R\}R + \{\varphi : S\}S$$

Computations for the Perturbations by Jupiter

[illegible]		[illegible]
μ	=	[illegible]
π	=	[illegible]
φ	=	[illegible]
☊	=	[illegible]
i	=	[illegible]
ω	=	[illegible]
[illegible]	=	1° [illegible]
[illegible]	=	[illegible]
[illegible]	=	[illegible]
[illegible]		[illegible]
[illegible]	=	[illegible]
[illegible]	=	[illegible]
[illegible]	=	[illegible]
[illegible]		[illegible]
[illegible]	=	0.9610
[illegible]	=	[illegible]
[illegible]	=	[illegible]
[illegible]	=	[illegible]
[illegible]		[illegible]
[illegible]		[illegible]
[illegible]		[illegible]

n = 400 days

$\lambda_{\text{[illegible]}}$ = 3.550000

$\lambda_{\text{[illegible]}} \frac{1}{\text{[illegible]}}$ = 5.31442

$\left(\frac{n + m}{\sqrt{\ }}\right)$ = 196481

[illegible]	[illegible]	Nov 22 [illegible]	[illegible]	Feb. 10 [illegible]
[illegible]	[illegible]	[illegible]	45° 23.7	60° 29.7
[illegible]	[illegible]	[illegible]	55 28.1	68 29.0
[illegible]	9.67529	[illegible]	9.91583	9.96563
[illegible]	9.94488	[illegible]	[illegible]	[illegible]
[illegible]	0.68819	[illegible]	0.44445	[illegible]
[illegible]	[illegible]	[illegible]	9.62014	[illegible]
[illegible]	0.01235	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.20587	0.11487	[illegible]	[illegible]
[illegible]	9.80645	[illegible]	[illegible]	[illegible]
[illegible]	32° 38.2	[illegible]	[illegible]	[illegible]
[illegible]	110 33.1	[illegible]	[illegible]	[illegible]
[illegible]	9.54537n	9.77005n	9.55930n	9.95602n
[illegible]	[illegible]	[illegible]	9.50069	9.63164
[illegible]	0.25109	0.19527	0.10413	9.94905
[illegible]	0.28051	[illegible]	[illegible]	0.31744
[illegible]	0.32760	[illegible]	[illegible]	0.30643
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	0.01467
[illegible]	9.71154	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	0.45516	[illegible]	[illegible]
[illegible]	[illegible]	9.04759	[illegible]	[illegible]
[illegible]	9.92536	9.52411	[illegible]	[illegible]
[illegible]	[illegible]	0.32433	[illegible]	[illegible]
[illegible]	0.23626	[illegible]	[illegible]	[illegible]
[illegible]	0.57661	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	9.03346	8.86792	[illegible]
[illegible]	1.45738	1.56543	1.73955	[illegible]

[illegible]	Feb. 10. 00	March 21. 0	[illegible]	[illegible]
[illegible]	72° 35'.7	[illegible] 41'.7	96° 47'.7	108° 53'.6
E	81 4.7	93 16.0	105 5.1	[illegible]
[illegible] E	9.99471	[illegible]	9.95477	9.95152
cos E	9.19057	[illegible]	9.41540$_n$	9.65064$_n$
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	7.71802	[illegible]	9.61291$_n$	[illegible]
r sin f	0.33177	[illegible]	[illegible]	[illegible]
[illegible]	9.99999	9.99067	9.96321	[illegible]
r cos f	[illegible]	9.65764$_n$	9.95490$_n$	0.11311$_n$
[illegible]	[illegible]	0.67571$_n$	0.36693$_n$	0.17047$_n$
[illegible]	[illegible]	101° 50'.1	[illegible]	[illegible]
u	167 [illegible]	179° 45.0	191 9.8	[illegible]
cos u	[illegible]	0.00000$_n$	9.99170$_n$	[illegible]
sin u	[illegible]	[illegible]	9.28692$_n$	9.57261$_n$
r sin u	9.66351	[illegible]	[illegible]	9.94279$_n$
[illegible]	0.33175	[illegible]	0.35862	[illegible]
[illegible]	0.30120	[illegible]	[illegible]	[illegible]
[illegible]	0.63298	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	9.97350	[illegible]
sin f	9.99999	9.99067	9.96321	9.91840
[illegible] sin f	[illegible]	0.63066	0.60981	0.57100
sin q sin f	9.17568	[illegible]	[illegible]	[illegible]
cos f	[illegible]	9.31195$_n$	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
cos f + cos E	9.20546	[illegible]	9.81626$_n$	[illegible]
[illegible]	0.62788	[illegible]	[illegible]	[illegible]
[illegible]	6.94238	[illegible]	8.80564$_n$	8.95723$_n$
[illegible]	0.00090	0.00330	1.84289	1.70048

1888.	July 19.0	[illegible]	Oct. 7.0	Nov. 16.0
M	120° 59'.6	[illegible]	145° 11'.6	[illegible]
E	[illegible]	138 [illegible]	149 [illegible]	160° 12'.1
sin E	[illegible]	9.81906	[illegible]	[illegible]
cos E	[illegible]	9.87616$_n$	[illegible]	[illegible]
y	[illegible]	0.07591	[illegible]	0.06419
cos E − [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	0.15012	[illegible]	[illegible]
[illegible]	[illegible]	9.90872$_n$	[illegible]	[illegible]
[illegible]	[illegible]	0.29706$_n$	[illegible]	[illegible]
[illegible]	[illegible]	9.85906$_n$	[illegible]	[illegible]
f	[illegible]	[illegible]	153° 39'.2	[illegible]
u	[illegible]	[illegible]	[illegible] 34.1	[illegible]
cos u	9.92741$_n$	[illegible]	9.79349$_n$	9.68764$_n$
sin u	[illegible]	[illegible]	[illegible]	9.94118$_n$
r sin u	0.10691$_n$	[illegible]	0.28871$_n$	0.34046$_n$
r	[illegible]	[illegible]	0.39475	0.39925
[illegible]	[illegible]	[illegible]	0.27084	0.26835
r + p	0.65752	[illegible]	0.66559	0.66767
[illegible]	[illegible]	[illegible]	9.93737	9.93254
sin f	[illegible]	[illegible]	[illegible]	9.46755
[p+r] sin f	0.51257	[illegible]	[illegible]	[illegible]
sin q sin f	9.03044	[illegible]	[illegible]	8.64327
cos f	9.84408$_n$	[illegible]	[illegible]	9.98044$_n$
y	0.27352	[illegible]	[illegible]	0.29759
cos f + cos E	0.11760$_n$	[illegible]	0.24505$_n$	[illegible]
[illegible]	0.67624	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	151615	[illegible]

	1888 Dec. 26	1889 Feb. 4	March. 16.	[illegible]
M	169° 23'.6	181° [illegible]	103° 35'.6	[illegible]
E	[illegible]	181 [illegible]	191 50.0	[illegible]
[illegible] E	9.20520	8.35689$_n$	[illegible]	[illegible]58134$_n$
[illegible] E	9.99434$_n$	9.99989$_n$	9.99067$_n$	9.96587$_n$
[illegible]	[illegible]	0.06066	0.06187	0.06524
[illegible] E − [illegible]	[illegible]	[illegible]	0.05254$_n$	[illegible]
[illegible] f	[illegible]	8.69395$_n$	[illegible]	9.91840$_n$
[illegible] f	[illegible]	[illegible]	[illegible]	9.97477$_n$
[illegible] f	0.39772$_n$	[illegible]	[illegible]	0.37310$_n$
[illegible] f	9.14454$_n$	8.29141	9.25442	9.54530
f	[illegible]	181° 7'.2	190° 11'.1	199° 20'.4
u	249 58.4	259 2.1	268 6.0	[illegible]
cos u	9.53461$_n$	[illegible]	[illegible]	[illegible]
sin u	9.97291$_n$	[illegible]	9.99976$_n$	9.99651$_n$
r sin u	[illegible]	0.39462$_n$	0.40119$_n$	0.39484$_n$
r	0.40191	[illegible]	0.40143	0.39833
[illegible]	0.26754	0.26721	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0.66919	0.66751
T_p	9.93021	9.92950	9.93069	9.93379
sin f	9.14035	[illegible]	[illegible]	[illegible]
[illegible]	9.80980	8.96116$_n$	9.91674$_n$	[illegible]
[illegible] f	8.31604	[illegible]	8.42324$_n$	[illegible]
cos f	9.99581$_n$	[illegible]	9.99310$_n$	[illegible]
[illegible]	0.30030	[illegible]	0.29982	0.29660
cos f + cos E	0.29611$_n$	[illegible]	0.29292$_n$	[illegible]
2r cos q	0.69801	[illegible]	0.69753	0.69443
[illegible] tan [illegible] cos f	9.20510$_n$	[illegible]	9.20239$_n$	9.18406$_n$
[illegible]	[illegible]	[illegible]	148102	1.49675

	[illegible]	[illegible]	[illegible]	[illegible]
{[illegible]}	[illegible]	0.06080$_n$	[illegible]	[illegible]
{[illegible]}	[illegible]	1.58361	1.48947	[illegible]
{[illegible]}	[illegible]	9.19165$_n$	9.26890$_n$	[illegible]
{[illegible]}	[illegible]	0.18513$_n$	0.17244$_n$	0.15844$_n$
{[illegible]}	[illegible]	[illegible]	[illegible]	[illegible]
{[illegible]}	[illegible]	[illegible]	[illegible]	[illegible]
{[illegible]}	[illegible]	[illegible]	[illegible]	[illegible]
{[illegible]}	1.08170$_n$	[illegible]	[illegible]	0.51726$_n$
{[illegible]}	[illegible]	[illegible]	[illegible]	1.43843
{[illegible]}	[illegible]	0.20926	[illegible]	0.32531
{[illegible]}	[illegible]	[illegible]	[illegible]	[illegible]

	[illegible]	[illegible]	[illegible]	[illegible]
{[illegible] : W}	[illegible]	[illegible]	[illegible]	[illegible]
{N : W}	1.04855	[illegible]	[illegible]	[illegible]
{μ : R}	9.31944m	[illegible]	[illegible]	[illegible]
{μ : S}	[illegible]	0.13020	[illegible]	[illegible]
{L : R}	0.62878m	0.63848m	0.64853m	0.65771m
{L : S}	[illegible]	[illegible]	9.48649	9.44817
{L : W}	[illegible]	6.20932	[illegible]m	[illegible]m
{π : R}	[illegible]m	0.46838	[illegible]	0.90437
{π : S}	[illegible]	[illegible]	[illegible]	[illegible]
{η : R}	[illegible]	[illegible]	[illegible]	0.23546
{η : S}	[illegible]	[illegible]m	0.15332m	0.34010m

	[illegible]	[illegible]	[illegible]	[illegible]
{L·W}	[illegible]	[illegible]	[illegible]	[illegible]
{N·W}	[illegible]	[illegible]	[illegible]	[illegible]
{U·R}	[illegible]	9.08722n	8.96664n	8.78703n
{U·S}	[illegible]	[illegible]	0.08113n	0.07660n
{L·R}	[illegible]	0.67250n	[illegible]	0.68161n
{L·N}	[illegible]	[illegible]	9.18995	[illegible]
{L·W}	[illegible]	8.52812n	[illegible]	8.65428n
{π·R}	1.00051	[illegible]	1.10880	1.13687
{π·S}	133088	[illegible]	[illegible]	[illegible]
{Q·R}	[illegible]	[illegible]	[illegible]	9.80464
{Q·S}	0.45466n	[illegible]	[illegible]	0.61500n

	Dec. 26.0	1889 Feb. 4.0	Mar. 16.0	Apr. 25.0
{ν : W}	9.93652$_n$	9.68185$_n$	8.92198$_n$	9.49969
{θ : W}	1.76016$_n$	1.77996$_n$	1.78653$_n$	1.78018$_n$
{μ : R}	8.45980$_n$	7.61078	8.56700	8.83951
{μ : S}	0.07397$_n$	0.07320$_n$	0.07445$_n$	0.07755$_n$
{L : R}	0.68382$_n$	0.68442$_n$	0.68341$_n$	0.68081$_n$
{L : S}	8.68697	7.83833$_n$	8.79391$_n$	9.06474$_n$
{L : W}	8.68864$_n$	8.70844$_n$	8.71501$_n$	8.70866$_n$
{π : R}	1.15224	1.15635	1.14953	1.13120
{π : S}	0.63452	9.78547$_n$	0.74105$_n$	1.01188$_n$
{ω : R}	9.47782	8.62830$_n$	9.58461$_n$	9.85712$_n$
{ω : S}	0.63317$_n$	0.63799$_n$	0.62995$_n$	0.60843$_n$

	Sept 3.0	Oct. 13.0	Nov 22.0	[illegible]	[illegible]	[illegible]
γ_0'	+ 1° [illegible]	+ 1° 4'.[illegible]	+ 1° 1'.[illegible]	+ [illegible]	+ [illegible]	[illegible]
λ_0	221° 17'.4	224° 21'.0	227° 25'.1	[illegible]	[illegible]	[illegible]
[illegible]	− [illegible]	− [illegible]	− [illegible]	− [illegible]	− [illegible]	[illegible]
$\sin(\gamma_0 - \delta b)$	[illegible]	9.70050$_n$	[illegible]	9.60575$_n$	[illegible]	[illegible]
$\cos\gamma_0$	9.99992	9.99992	9.99993	9.99994	[illegible]	[illegible]
$\cos(\gamma_0 - \nu)$	9.92272	9.93702	[illegible]	9.96083	[illegible]	[illegible]
[illegible]	8.28717	8.27191	8.25469	8.23529	[illegible]	[illegible]
	9.99973	9.99970	9.99966	9.99961	[illegible]	[illegible]
[illegible]	9.73808$_n$	9.70042$_n$	[illegible]	[illegible]	[illegible]	[illegible]
u	− 2° 1'.7	− 2° 5'.1	− 2° 15'.5	− 2° 2[illegible]	− [illegible]	− [illegible]
$u - i$	− 4° 23'.3	− 4° 29'.7	− 4° 37'.4	− 4° 47'.0	− 4° [illegible]	− [illegible]
$\sin(u-i)$	8.88375$_n$	8.89416$_n$	8.90636$_n$	8.92110	8.93914$_n$	8.96195$_n$
q	9.73835$_n$	9.70072$_n$	[illegible]	[illegible]	[illegible]	9.48533$_n$
$\cos(u-i)$	9.99873	9.99866	9.99859	9.99845	9.99836	9.99817
$\cos B_1 \sin b$	9.73705$_n$	9.69938$_n$	9.65662$_n$	9.60761$_n$	[illegible]	[illegible]
	9.92302	[illegible]	9.94992	[illegible]	9.97065	9.97856
$\cos B_1 \cos b$	[illegible]	9.93694	9.94963	9.96077	9.97044	9.97870
b	− 33° 7'.0	− 30° 3'.4	− 26° 59'.4	− 23° 54'.9	− 20° 49'.6	− 17° 43'.9
$\cos B_1$	9.99962	9.99966	[illegible]	9.99975	[illegible]	[illegible]
n	[illegible]	[illegible]	[illegible]	[illegible]	0.73150	0.73069
$\sin B_1$	8.62210	8.59458	8.56439	[illegible]	8.49145	[illegible]
$b_1 - u$	−143° 40'.1	−[illegible]	−167° 47'.7	−175° 33'.7	−[illegible]	−197° 25'.9
$\cos(b_1 - u)$	[illegible]	9.96119$_n$	[illegible]	9.99956$_n$	[illegible]	[illegible]
$r\cos B$	0.73382	[illegible]	[illegible]	0.73200	[illegible]	[illegible]
$\sin(b_1 - u)$	9.77266$_n$	[illegible]	9.32512$_n$	8.39969$_n$	9.16623	9.47770

	Sept 30	Oct. 15.0	[illegible]	[illegible]	[illegible]	March 21.0
ξ_1	0.63994	0.69446$_n$	[illegible]	[illegible]	[illegible]	0.70999
η	0.25051	0.29075	[illegible]	0.31744	[illegible]	[illegible]
ζ	0.51691	0.54520	[illegible]	0.55590	[illegible]	0.52032
$\xi - \eta$	0.79742$_n$	0.83895$_n$	[illegible]	[illegible]	0.87360$_n$	0.86600$_n$
	9.94949	9.97919	[illegible]	9.99993	9.99759	9.98975
η_1	0.50648$_n$	0.34025$_n$	[illegible]	[illegible]	9.89752	0.20823
[illegible]	0.84703$_n$	0.85976$_n$	[illegible]	0.87341$_n$	0.87601$_n$	0.87625$_n$
	9.99977$_n$	9.99981$_n$	9.99984$_n$	9.99987$_n$	9.99989$_n$	9.99991$_n$
ζ	9.35630	9.32849	9.29735	9.26248	9.22295	9.17800
ξ^{-1}	[illegible]	9.14005	[illegible]	9.12646	[illegible]	9.12366
ξ^{-3}	7.45552	7.42015	7.39513	[illegible]	7.37164	[illegible]
η^{-2}	[illegible]	[illegible]	7.80112	7.80325	7.80550	[illegible]
ζ	0.07819	0.14413	0.18943	0.21849	[illegible]	[illegible]
$\bar{\kappa}$	[illegible]	7.56428	7.58456$_n$	7.59[illegible]	7.60605$_n$	7.61027$_n$
$\xi \bar{\kappa}$	8.17365	8.25874	8.30730	[illegible]	8.33262	8.32026
[illegible]	7.73603	7.71090	7.69857	[illegible]	[illegible]	7.71666
ζ	0.24034	0.40321	0.48599	[illegible]	[illegible]	0.47917
$\bar{\kappa}_0$	[illegible]	8.11411	8.18456	[illegible]	[illegible]	[illegible]
ξ_0	8.04019	7.90453	7.64235	6.72956	7.50377$_n$	7.81550$_n$
κ_0	6.89001$_n$	6.89277$_n$	6.88191$_n$	6.86035$_n$	6.82900$_n$	6.78527$_n$
$\bar{\kappa}$	[illegible]	0.07892	0.14937	0.17942	[illegible]	0.16064
ξ	0.00500	9.86934	9.60716	8.69437	9.46838$_n$	9.78331$_n$
κ	[illegible]	8.85758$_n$	8.84672$_n$	[illegible]	[illegible]	[illegible]

	[illegible]	Oct. 13.0	Nov. 22.0	1888 Jan 1	Feb. 10.0	March 21.0
$\Delta\omega$	+ 0.045	+ 0".083	+ 0".110	+ 0".125	+ 0".130	+ 0".126
$\Delta\omega$	− [illegible]	− 2.762	− 2.169	− 1.444	− 0.696	− 0.013
$\Delta\mu_1$	− 0".095	− 0".156	− 0".262	− 0".307	− 0".317	− 0".296
$\Delta\mu_2$	− 1.586	− 1.134	− 0.602	− 0.071	+ 0.410	+ 0.810
$\Delta\mu$	− [illegible]	− 1.320	− 0.864	− 0.375	+ 0.093	+ 0.523
ΔL_1	− [illegible]	− 4".762	− 5".713	− 6".264	− 6".456	− 6.297
ΔL_2	− 0.167	+ 0.170	+ 0.113	+ 0.015	− 0.095	− 0.195
ΔL_3	− [illegible]	− 0.002	− 0.002	− 0.001	− 0.001	− 0.000
ΔL	− [illegible]	− 4.594	− 5.602	− 6.250	− 6.552	− 6.492
$\Delta\pi_1$	− 10".545	− 11".467	− 9".215	− 4".974	− 0".115	+ 4".256
$\Delta\pi_2$	+ 14.766	+ 15.094	+ 9.999	+ 1.358	− 8.427	− 17.309
$\Delta\pi$	+ 4.223	+ 3.627	+ 0.784	− 3.616	− 8.545	− 13.053
$\Delta\varphi_1$	+ 1".024	+ 1.942	+ [illegible]	+ [illegible]	+ [illegible]	+ [illegible]
$\Delta\varphi_2$	+ 3.787	− [illegible]	+ [illegible]	+ 0.064	− [illegible]	− [illegible]
$\Delta\varphi$	+ 4.811	+ 4.209	+ 3.627	+ 3.261	+ 3.195	+ 3.425

	April 30	[illegible]	July 19.0	Aug. 28.0	[illegible]	[illegible]
β_0	− 0° [illegible]	[illegible]	+ 0° 43'.0	+ 0° 39'.3	+ 0° 35'.5	[illegible]
γ_0	239 47.8	24[illegible]	[illegible]46 3.5	249 12.6	[illegible] 22[illegible]	[illegible]
$\gamma_0 - \Omega$	− [illegible]	− 11 [illegible]	− [illegible] 24.[illegible]	− 5 15.4	− 2 5.5	+ 1 [illegible]
$\sin(\gamma_0 - \Omega)$	9.40355	9.30132$_n$	9.16503$_n$	[illegible]	[illegible]	8.27860
$\cos\beta_0$	9.99995	9.99996	[illegible]	9.99997	9.99998	[illegible]
$\cos(\gamma_0 - \Omega)$	9.98560	9.99113	9.99531	9.99817	9.99971	9.99992
$\sin\beta_0$	8.16181	8.1311[illegible]	8.09[illegible]	− [illegible]	[illegible]	7.96341
	9.99929	[illegible]	[illegible]	[illegible]	[illegible]	9.95430
$\cos\beta_0 \sin(\gamma_0 - \Omega)$	9.40350	9.30124$_n$	9.16[illegible]$_n$	[illegible]96196$_n$	[illegible]	8.27858
G	− 3° 16'.8	− 3° 52'.0	− 4° [illegible]4	− [illegible]° 6'.8	− 15° 4[illegible].1	+ 23° 49'.6
$G - i$	− 5° 38.4	− 6 13.6	− [illegible] 1[illegible].0	− [illegible] 25.4	− 18° [illegible]	+ 23° 25.0
$\sin(G-i)$	8.99245$_n$	9.03528$_n$	9.1[illegible]106$_n$	9.[illegible]1640$_n$	9.49336$_n$	9.60012
q	9.40421$_n$	9.30227$_n$	9.16655$_n$	8.96531$_n$	[illegible]	[illegible]
$\cos(G-i)$	9.99789	[illegible]	[illegible]651	[illegible]403	[illegible]	9.96251
$\cos B_1 \sin L$	9.40210$_n$	9.29970$_n$	9.16309$_n$	[illegible]95934	8.55679$_n$	8.28679
	[illegible]	[illegible]	9.99534	[illegible]	[illegible]	9.99992
$\cos B_1 \cos L$	9.98555	9.99109	9.99528	9.99814	9.99969	[illegible]
L	− 14° 37'.5	− 11° 30'.2	− 8° 22'.3	− 5° 13'.5	− 2° 3'.9	+ 1° 6'.5
$\cos B_1$	9.99986	9.99990	9.99994	9.99995	9.99997	9.99998
r_1	0.72984	0.72894	[illegible]	0.72701	[illegible]	0.72492
$\sin B_1$	8.39666	8.33755	[illegible]	8.18171	[illegible]	7.92440
$L_1 - u$	− 20° 5 47'.3	− [illegible]	− [illegible]	− [illegible] 16'.[illegible]	− [illegible]	− [illegible]
$\cos(L_1 - u)$	9.95444$_n$	[illegible]	9.68051$_n$	9.83153$_n$	[illegible]	[illegible]
$r_1 \cos B$	0.72970	0.72884	[illegible]	0.72696	0.72595	0.72490
$\sin(L_1 - u)$	9.63854	9.74134	[illegible]	9.86608	9.90592	9.93639

	April 20.0	[illegible]	July 19.0	[illegible]	Oct. 7.0	[illegible]
ξ_0	0.65414$_m$	0.65019$_m$	0.60844$_m$	0.55849$_m$	0.49897$_m$	[illegible]$_m$
η	[illegible]	0.37018	0.38014	0.38834	[illegible]	0.29928
ζ	0.40360	0.46323	0.43001	0.39439	0.35626	0.31525
$\xi - \eta$	0.55222$_m$	[illegible]$_m$	[illegible]$_m$	[illegible]$_m$	0.75101$_m$	0.71453$_m$
	9.97779	9.96264	9.94474	9.92425	9.90098	9.87448
η_1	[illegible]	0.47018	0.54121	0.59304	[illegible]	0.66129
[illegible]	0.87443$_m$	0.87077$_m$	0.86541$_m$	[illegible]$_m$	0.85003$_m$	0.84005$_m$
	9.99993$_m$	[illegible]	[illegible]$_m$	9.99997$_m$	9.99995	9.99999
ζ	9.12650	[illegible]	[illegible]563	8.90872	8.79828	[illegible]
ξ^{-1}	[illegible]	[illegible]	[illegible]	[illegible]	9.14995	[illegible]
ξ^{-3}	[illegible]650	[illegible]	[illegible]40365	[illegible]42447	[illegible]	[illegible]
η^{-3}	[illegible]81045	[illegible]	[illegible]81603	[illegible]81807	[illegible]	[illegible]82524
ϱ	0.23462	[illegible]	0.19990	[illegible]	0.13232	0.08466
K	[illegible]$_m$	[illegible]	[illegible]$_m$	[illegible]	[illegible]$_m$	[illegible]$_m$
ξK	8.29526	[illegible]	8.21199	8.15330	8.08114	[illegible]
$\eta \xi^{-3}$	[illegible]8512	[illegible]	[illegible]78379	[illegible]81281	[illegible]84460	[illegible]
ζ	0.42028	[illegible]	0.22541	[illegible]	[illegible]	9.47143
π_0	[illegible]	[illegible]	8.00920	[illegible]88844	[illegible]0434	[illegible]
δ_0	[illegible]936$_m$	[illegible]$_m$	8.14476	8.18755$_m$	8.21404$_m$	[illegible]$_m$
w_0	[illegible]	[illegible]$_m$	6.59918$_m$	6.50353	6.38045$_m$	[illegible]$_m$
π	0.12021	0.05939	9.97401	9.85325	9.66915	9.31534
δ	[illegible]$_m$	0.04385$_m$	0.10957$_m$	0.15266$_m$	[illegible]$_m$	0.19058
w	[illegible]	[illegible]$_m$	8.56399$_m$	8.46824$_m$	[illegible]$_m$	8.17861

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$\Delta\iota$	+ 0.113	+ [illegible]	+ 0.074	+ [illegible]	+ 0.034	+ 0.018
$\Delta\epsilon$	+ 0.541	+ [illegible]	+ 1.138	+ 1.166	+ 1.185	+ [illegible]
Δu_1	− 0.253	− [illegible]	− 0.141	− [illegible]	− 0.043	− 0.013
Δu	+ 1.152	+ 1.411	+ 1.664	+ 1.730	+ 1.820	+ 1.850
Δu	+ 0.899	+ 1.213	+ 1.463	+ 1.682	+ [illegible]	+ 1.837
ΔL_1	− 5.371	− 5.213	− 4.362	− 3.305	− 2.223	− 0.993
ΔL	− 0.270	− 0.310	− 0.316	− 0.285	− 0.234	− 0.160
ΔL_2	+ 0.000	− 0.001	+ 0.001	+ 0.001	+ 0.001	+ 0.001
ΔL	− 6.141	− 5.522	− 4.677	− 3.642	− 2.476	− 1.152
$\Delta\pi_1$	+ 7.464	+ 9.199	+ 9.430	+ 8.287	+ 7.997	+ 2.833
$\Delta\pi_2$	− 23.894	− 27.490	− 27.954	− 23.522	− 22.699	− 14.129
$\Delta\pi$	− 16.430	− 18.291	− 18.524	− [illegible]	− 14.702	− 11.296
$\Delta\sigma_1$	+ 2.623	+ [illegible]	+ 1.465	+ 0.905	+ 0.450	+ [illegible]
$\Delta\sigma_2$	+ [illegible]	+ [illegible]	+ 3.666	+ 4.825	+ [illegible]	+ [illegible]
$\Delta\sigma$	+ 3.885	+ 4.486	+ 5.131	+ [illegible]	+ 6.217	+ [illegible]

	Dec. 26.0	[illegible]	March 16	April 25.0
β_0	+ 0° 27'.5	+ 0° 23'.3	+ 0° 10'.1	+ 0° 14'.7
λ_0	258 45.1	161 [illegible]	265° 11'.7	268° 26'.5
$\lambda_0 - \Omega$	+ 4° 17'.1	+ 7° [illegible]	+ 10° 43'.7	+ 13 58.5
$\sin(\lambda_0' - \Omega)$	8.87342	[illegible]11560	[illegible]	[illegible]
$\cos\beta_0'$	9.99999	9.99999	[illegible]	[illegible]
$\cos(\lambda_0' - \Omega)$	9.99879	[illegible]9227	9.99234	[illegible]
$\sin\beta_0$	[illegible]	[illegible]	7.74476	7.63104
	[illegible]	[illegible]	9.99981	9.99993
$\cos\beta_0' \sin(\lambda_0' - \Omega)$	8.87341	[illegible]	[illegible]	[illegible]
a	+ 6° 6'.[illegible]	+ [illegible]	+ 1° 4[illegible]	+ 1° [illegible]
$a - i$	+ 3° 45'.1	+ [illegible]	− 0° 30'.0	− 1° [illegible]
$\sin(a - i)$	8.81570	8.02954	8.05475$_n$	8.37055$_n$
r_1	[illegible]	9.11617	9.27005	9.38299
$\cos(a - i)$	[illegible]	9.99997	[illegible]	9.99988
$\cos B_1 \sin L$	8.87488	9.11614	9.27002	9.38287
$\cos$	9.99878	9.99626	9.99233	9.98696
$\cos B_1 \cos L$	9.99878	9.99626	9.99233	9.98696
L	+ 4° 18'.0	+ 7° 30'.5	+ 10° 43'.9	+ 13° 58'.4
$\cos B_1$	0.00000	[illegible]	[illegible]	[illegible]
r_1	0.72383	[illegible]	[illegible]	[illegible]
$\sin B_1$	7.69160	[illegible]	[illegible]	[illegible]
$L_1 - u$	− 245° 40'.0	− 251° [illegible]	− [illegible]	− [illegible]
$\cos(L_1 - u)$	[illegible]	[illegible]	[illegible]	[illegible]
$\cos B_1 r_1$	0.72383	[illegible]	[illegible]	[illegible]
$\sin(L_1 - u)$	9.95060	[illegible]	[illegible]	[illegible]

	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	9.78847n
r	[illegible]	[illegible]	[illegible]	0.30833
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ξ − r	[illegible]	[illegible]	[illegible]	0.40369n
	[illegible]	[illegible]	9.91045	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	0.71730
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	0.00000n	9.99999n
[illegible]	[illegible]	[illegible]	8.04638n	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	7.64500
[illegible]	[illegible]	[illegible]	[illegible]	7.53883
[illegible]	[illegible]	[illegible]	[illegible]	9.73406
[illegible]	[illegible]	[illegible]	7.45881n	7.38505n
[illegible]	[illegible]	[illegible]	[illegible]	7.17652
[illegible]	[illegible]	[illegible]	[illegible]	8.04732
[illegible]	[illegible]	[illegible]	[illegible]	0.80700
F_0	683053n	[illegible]	7.82533n	[illegible]
S_0	8.22360n	[illegible]	8.16972n	[illegible]
W_0	5.95560n	[illegible]	[illegible]	5.56197
T	[illegible]	[illegible]	9.79014n	[illegible]
S	0.15550n	[illegible]	0.13453n	0.07025n
W	[illegible]	[illegible]	7.47000	7.82075

	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

The integration [illegible] means of mechanical quadratures is performed according to the following formulae —

$$^{I}f(a - \tfrac{1}{2}w) = -\tfrac{1}{24}f'(a - \tfrac{1}{2}w) + \tfrac{17}{5760}f'(a - \tfrac{1}{2}w) + \cdots$$

$$''f(a) = \tfrac{1}{24}f(a - w) - \tfrac{17}{5760}\left\{-f''(a - w) + f'(a)\right\} + \cdots$$

$$\int^{a+iw} f(x)\,dx = {}'f(a + iw) - \tfrac{1}{12}f'(a + iw)$$

$$\iint^{a+iw} f(x)\,dx^2 = {}''f(a + iw) + \tfrac{1}{12}(a + iw).$$

$$L = L_0 + u_0 t + \Delta L_1 + \Delta L_2$$

$$= L_0 + u_0 t + \int\left(\frac{dL}{dt}\right)dt + \iint\left(\frac{du}{dt}\right)dt^2$$

$$\Delta \eta_0 = \Delta L - \Delta\pi - \Delta u t.$$

$$T = \text{Jan. 0.0 1888.}$$

1887						
Sept. [illegible]				−3″[illegible]		
	−1		+3[illegible]		+[illegible]	
Oct. 13.0		+2[illegible]		2,76[illegible]		+[illegible]
	−1[illegible]		+[illegible]		+[illegible]	
Nov. 22.0		+1[illegible]		−2,164		+[illegible]
1888	−1[illegible]		+7[illegible]		−0,031	
Jan. 1.0		+[illegible]		−1,444		−[illegible]
	−[illegible]		+7[illegible]		−1,475	
Feb. 10.0		−6[illegible]		−0,696		−1,884
	−64		+683		−2,171	
Mar. 21.0		−1[illegible]		−0,012		−2,230
	−36		+[illegible]		−2,1[illegible]	
Apr. 30.0		−16[illegible]		+0,541		−1,753
	−16		+3[illegible]		−1,643	
June 1.0		−1[illegible]		+0,930		−1,203
	+4		+208		−0,713	
July 19.0		−177		+1,138		−0,154
	+22		+31		+0,425	
Aug. 28.0		−1[illegible]5		+1,169		+1,[illegible]
	+36		−124		+1,[illegible]4	
Oct. 7.0		−119		+1,045		+1,13[illegible]
	+3[illegible]		−243		+2,6[illegible]	
Nov. 16.0		−80		+0,802		+3,06[illegible]
	+[illegible]		−323		+3,441	
Dec. 26.0		−24		+0,47[illegible]		+3,70[illegible]
	+[illegible]		−347		+3,920	
1889 Feb. 4.0		+[illegible]4		+0,132		+4,[illegible]
	+[illegible]		−31[illegible]		+40[illegible]	
Mar. 16.0		+[illegible]		−0,1[illegible]		[illegible]
			−1[illegible]		+3,871	
April 25.0				−0,[illegible]		

1887						
Sept. 3.0			−601	+4.223		
		2.247		+1.627	+4.225	−2.2[illegible]
Oct. 13.0	+6[illegible]		−2.843		[illegible]	
Nov. 22.0		1.5[illegible]7		+0.784		+[illegible].111
1888	+1.12[illegible]		−4.400		+0.186	
Jan. 1.0		−[illegible]		−3.616		−1.218
	+9.50		−4.427		−[illegible]	
Feb. 10.0		+.421		−[illegible]45		−[illegible]
	+710		−4[illegible]		−11.97[illegible]	
Mar. 21.0		+1.131		−13.0[illegible]		−18.16[illegible]
	+[illegible]		−.373		−25.02[illegible]	
Apr. 30.5		+1.516		−16.430		−33.021
	+112		−1.561		−41.458	
June 9.5		+1.62[illegible]		−18.243		−[illegible]0.71[illegible]
	+106		−0.2[illegible]3		−57.749	
July 19.5		+1.[illegible]72		−18.524		−1[illegible]9.176
	−278		+1.289		−78.273	
Aug. 28.0		+1.244		−17.235		−1 27.054
	−371		+2.5[illegible]		−7[illegible]	
Oct. 7.0		+.[illegible]		−14.702		−1 43.113
	[illegible]		+3.406		−1′ 50.2[illegible]0	
Nov. 16.0		+.[illegible]1		−11.296		−1 [illegible].164
	−[illegible]24		+3.7[illegible]7		−2 1[illegible]06	
Dec. 26.0		+.173		−2.[illegible]9		−2 [illegible]91
1889	−650		+2.[illegible]84		−2 [illegible].045	
Feb. 4.0		+.[illegible]		−[illegible]		−2 11.[illegible]47
	[illegible]		+1.261		−2 13.000	
Mar. 16.0		+1.522		−1.174		−2 13.[illegible]
			+1.239		−2 14.[illegible]	
Apr. [illegible]				+[illegible]		

1887				Δi		
Sept. [illegible]	[illegible]	[illegible]	[illegible]	+[illegible]		
			+[illegible]		−0,194	
[illegible] 1[illegible],0		−[illegible]		+0,083		−0,[illegible]
	−[illegible]		+[illegible]		−0,111	
Nov. 22,[illegible]		−12		+0,110		−[illegible]
[illegible]	+[illegible]		+15		−0,[illegible]01	
[illegible] 1,0		−10		+0,12[illegible]		+[illegible]61
	+1		+[illegible]		+0,124	
Feb. 10,0		−9		+0,130		+0,189
	0		−4		+2,254	
[illegible] 21,0		−[illegible]		+0,126		+0,318
	+4		−1[illegible]		+0,380	
Apr. 30,0		−[illegible]		+0,113		+0,438
	+2		−18		+0,493	
[illegible] 9,0		−[illegible]		+0,095		+0,[illegible]42
	+[illegible]		−21		+0,588	
July 19,0		[illegible]		+0,074		+0,627
	+2		−21		+0,662	
Aug. 28,0		+[illegible]		+0,05[illegible]		+0,67[illegible]
	+1		−19		+0,715	
Oct. 7,[illegible]		+3		+0,03[illegible]		+0,734
	+2		−16		+0,749	
N[illegible] 16,0		+[illegible]		+[illegible]01[illegible]		+0,759
	0		−11		+0,767	
Dec. 26,0		+[illegible]		+[illegible]007		+0,771
1889	0		−6		+0,774	
Feb. 4,0		+[illegible]		+[illegible]001		+0,77[illegible]
	−2		−1		+0,77[illegible]	
[illegible] 6,0		[illegible]		−[illegible]		+0,775
			+2		+0,77[illegible]	
Apr. 2[illegible]						

1887							
[illegible]	[illegible]				+4,[illegible]11		
				−[illegible]02		−7,8[illegible]	
[illegible]	[illegible]		+ 20		+4,2[illegible]		[illegible],666
		+196		−582		−3,611	
[illegible]	[illegible]		+216		+3,627		−1,[illegible]
1888		+ 84		− 66		+0,016	
[illegible]	[illegible]		+[illegible]		+3,261		+1,[illegible]
		− 4		− 66		+3,277	
[illegible]	10.0		+296		+3,195		+4,868
		− 66		+230		+6,472	
[illegible]	21.0		+230		+3,42[illegible]		+8,156
		− 89		+460		+[illegible]	
[illegible]	[illegible]		+141		+3,8[illegible]		+11,845
		− 97		+601		+13,872	
[illegible]	[illegible]		+ 44		+4,486		+[illegible]
		− 87		+64[illegible]		+[illegible]	
July	1[illegible]		− 43		+5,131		+20,782
		− 75		+602		+2[illegible]	
[illegible]	2[illegible]		−118		+5,[illegible]		+[illegible]
		− 58		+434		+29,132	
[illegible]	7.0		−176		+6,217		+[illegible]
		− 44		+3[illegible]		+35,349	
[illegible]	16.[illegible]		−22[illegible]		+6,[illegible]2[illegible]		[illegible]
		− 25		+ [illegible]		+41,874	
[illegible]	26.0		−24[illegible]		+6,613		+[illegible]
1889		− 3		− [illegible]7		+4[illegible],4[illegible]7	
[illegible]	[illegible]		−24		+6,4[illegible]6		+[illegible]
		+ 1[illegible]		−[illegible]		+[illegible]	
[illegible]	1[illegible]		−2[illegible]		+[illegible]		+[illegible]
				−[illegible]		+60,994	
[illegible]	[illegible]				+[illegible]3		

[illegible]									
Sept. 2.0				−1,634		−3,024	$\int \frac{d\mu}{dt} dt$	$\int \frac{d\mu}{dt} dt$	[illegible]
			−364		+1,[illegible]				
Oct. 13.0		+92		−1,320		−0,860	+1,469	+0,037	−[illegible]
	−6,2		+456		+0,844				
[illegible] 22.0		+30		−0,864		−0,016	+0,372	+0,009	−[illegible]
1888	−0,5		+[illegible]		−0,020				
Jan. 1.0		−15		−0,378		−[illegible]	−[illegible]	−[illegible]	−[illegible]
			+471		−0,398				
Feb. 10.0		−41		+0,093		−[illegible]	−[illegible]	−[illegible]	−0,426
	−[illegible]		+430		−0,305				
Mar. 21.0		[illegible]4		+[illegible]		−0,739	−0,077	−[illegible]02	−0,6[illegible]
	−5		+76		+0,218				
Apr. 30.0		−62		+0,899		−[illegible]	+0,640	+0,[illegible]16	[illegible],446
	−2		+[illegible]		+1,117				
June 1.0		−64		+[illegible]		+[illegible]46	+1,[illegible]	+0,[illegible]43	+[illegible],677
	+3		+250		+[illegible]				
July 11.0		−61		+1,463		+2,926	+3,044	+0,076	+[illegible]43
	−[illegible]		+189		+[illegible]				
Aug. 28.0		−64		+1,652		+6,719	+4,606	+0,115	+6,8[illegible]7
	−1		+12[illegible]		+[illegible]				
Oct. 7.0		−65		+1,777		+12,164	+6,326	+0,158	+1[illegible],312
	[illegible]		+60		+7,222				
Nov. 16.0		−65		+1,837		+1[illegible],386	+[illegible]	+0,20[illegible]	+19,[illegible]
	−8		−[illegible]		+9,059				
Dec. 26.0		−73		+1,832		−28,445	+9,978	+0,249	+2[illegible]
1889	−11		−[illegible]		+10,891				
Feb. 4.0		−81		+1,[illegible]		+39,336	+11,778	+0,294	+[illegible],432
			−159		+12,645				[+[illegible]]
Mar. 16.0		−[illegible]2		+1[illegible]		+51,981	+13,460	+0,337	+[illegible]2,115
			−[illegible]		+[illegible]				
Apr. [illegible]				+1[illegible]		+[illegible]			

1887	[illegible]	[illegible]	[illegible]	Δh	[illegible]	$\int \frac{dh}{dt} dt$	$\int \left(\frac{dh}{dt}\right)^2 dt$	$a_0 t + h_0$	h
Sept. 3.0				−3,2[illegible]					
			−1,[illegible]44		+10,2[illegible]				
Oct. 13.0		+3[illegible]		−4,[illegible]	+	+[illegible]	−0,970	8° 41′ [illegible]1″,	8° 41′ 10″,2
	+[illegible]		−1,[illegible]		+[illegible]			2[illegible]	
[illegible]		+[illegible]		−[illegible]2		+2,[illegible]17	−[illegible]	26 46 57,1;	20 46 59,9
1888	−1[illegible]		−[illegible]		+6,[illegible]27				
Jan. 1.0		+[illegible]48		−6,[illegible]		−3,0[illegible]58	−0,067	32 52 51,1;	32 52 48,4
	+[illegible]		−[illegible]		−6,[illegible]				
Feb. 10.0		+3[illegible]		−[illegible]		−9,488	−0,426	44 58 45,1;	44 58 35,1
	−[illegible]		+		−12,773				
[illegible]		+[illegible]		−[illegible]12		−16,036	−0,695	57 4 39,1;	57 4 22,4
	−[illegible]		+[illegible]		−19,265				
[illegible]		+[illegible]		−[illegible]41		−[illegible]76	−0,446	69 10 33,1;	69 10 10,3
	−42		+		−2[illegible],406				
June 9.0		+[illegible]26		−[illegible]22		−[illegible],230	−[illegible]47	81 16 27,1;	81 15 59,6
	−[illegible]6		+		−30,[illegible]				
[illegible]		+140		−4,[illegible]77		−[illegible]340	+3,048	93 22 21,1;	93 21 50,[illegible]
	3[illegible]		+[illegible]		−[illegible]5,[illegible]05				
Aug. 28.0		+151		−3,642		−37,520	+6,857	105 28 15,1;	105 27 44,5
	−3[illegible]		+1[illegible]		−3[illegible],247				
Oct. 7.0		+118		−[illegible]6		−[illegible]	+1[illegible],[illegible]12	117 34 9,1;	117 33 41,9
	−44		+1[illegible]		−41,[illegible]				
Nov. 16.0		+74		−1,152		−42[illegible]	+1[illegible]	129 40 3,1;	129 39 40,3
	−1		+1[illegible]		−42,855				
[illegible]		+[illegible]		+[illegible]26		−4[illegible]	+[illegible]8	141 45 57,1;	141 45 42,9
[illegible]	−[illegible]		+1,421		−42,629				
Feb. 4.0		−[illegible]		+1,[illegible]47		−41,924	+39,482	153 51 51,1;	153 51 48,7
	−[illegible]		+1[illegible]		−40,982	[−4[illegible]	+[illegible]	[illegible]	[illegible]
Mar. 16.0		−70		+3[illegible]		−39,567	+52,115	165 57 45,1;	165 57 57,7
			+1,[illegible]		−37,922				
[illegible]				+4,40[illegible]					

[illegible]	1	−5,666	[illegible]		−0,74[illegible]		
[illegible]	23	4,[illegible]					
[illegible]	2	−3,789	[illegible]	+[illegible]		+1,[illegible]	[illegible]
	12	−2,742	[illegible]			+2,0[illegible]1	
	22	−1,758	[illegible]		−0,485		[illegible]
[illegible]	2	−0,726	[illegible]			+1,[illegible]	
	12	−0,090	[illegible]	+[illegible]			+[illegible]
[illegible]	22	+0,742	[illegible]			+1,[illegible]	
Jan.	1	+1,665			[illegible]		[illegible]17
[illegible]	11	+2,473	[illegible]			+1,[illegible]	
[illegible]	21	+[illegible]747	[illegible]	+[illegible]			+[illegible]
[illegible]	[illegible]1	+4,054	[illegible]			+[illegible]	
[illegible]	10	+4,868	[illegible]		+[illegible]		+[illegible]
[illegible]	20	+5,671	[illegible]			+[illegible]614	
[illegible]	1	+6,482	[illegible]	+[illegible]			
[illegible]	11	+7,230	[illegible]			+[illegible]	+0,[illegible]
[illegible]	21	+8,156	[illegible]		+[illegible]401		[illegible]
[illegible]	[illegible]1					+[illegible]	
[illegible]	10	+9,[illegible]		+[illegible]			
[illegible]	20						
[illegible]	30	+11,845			+[illegible]		

1 L.

1887							
[illegible]	[illegible]	+[illegible]			[illegible]		[illegible]
[illegible]	[illegible]	+2,[illegible]				[illegible]	
[illegible]	[illegible]	+1,[illegible]		-[illegible]			[illegible]
	12	+1,[illegible]				[illegible]	
[illegible]	[illegible]	+[illegible]			+[illegible]		[illegible]
[illegible]	2	+[illegible]				[illegible]	
	12	-0,[illegible]		-[illegible]			[illegible]
	[illegible]	-0,474				[illegible]	
[illegible]	1	[illegible]			[illegible]		[illegible]
[illegible]	11	-1,140				[illegible]	
	21	-1,431		-[illegible]			[illegible]
[illegible]	1	-1,[illegible]				[illegible]	
[illegible]	10	-1,[illegible]			[illegible]		[illegible]
	20	-2,[illegible]				[illegible]	
[illegible]	1	-2,141		-[illegible]			[illegible]
[illegible]	11	-2,206				[illegible]	
[illegible]	21	-2,[illegible]			[illegible]		[illegible]
	1	-2,160		+[illegible]			
[illegible]	10	-1,[illegible]					[illegible]
[illegible]	20				[illegible]	[illegible]	
[illegible]	[illegible]	-1,[illegible]					

[illegible]						
[illegible]		[illegible]				
	[illegible]	[illegible]				
[illegible]	[illegible]	[illegible]	[illegible]			[illegible]
	12	[illegible]				
	[illegible]	[illegible]		[illegible]		[illegible]
[illegible]	[illegible]	[illegible]				
	12		[illegible]			[illegible]
	22	[illegible]			[illegible]	
[illegible]	1	[illegible]		[illegible]		[illegible]
	11	[illegible]			[illegible]	
	[illegible]	[illegible]	[illegible]			[illegible]
	1	[illegible]			[illegible]	
[illegible]	[illegible]	[illegible]		[illegible]		[illegible]
	[illegible]	[illegible]			[illegible]	
[illegible]	1	[illegible]	[illegible]			
	11	[illegible]			[illegible]	
	[illegible]	[illegible]		[illegible]		
[illegible]	1					
[illegible]	[illegible]		[illegible]			
	[illegible]					
	[illegible]	[illegible]				

[illegible]

[illegible]		[illegible]					
		[illegible]	[illegible]		[illegible]		
			+0,691			[illegible]	
[illegible]	2	[illegible]		+1,[illegible]			[illegible]
	12	−0,164				[illegible]	
	22	+0,111	[illegible]		[illegible]		[illegible]
[illegible]	[illegible]	+0,04[illegible]				[illegible]	
	12	−0,009	[illegible]	−1,[illegible]			[illegible]
	22	−0,448	[illegible]			[illegible]	
[illegible]	1	−1,218	−0,770		[illegible]		[illegible]
	11	−2,287	−1,069			[illegible]	
	21	−[illegible]661	−1,[illegible]74	−6,07[illegible]			[illegible]
	[illegible]	[illegible]	−1,465			[illegible]	
[illegible]	10	−7,2[illegible]	[illegible]		4,7[illegible]		[illegible]
[illegible]	[illegible]	−9,592	−2,296			[illegible]	
[illegible]	1	−12,1[illegible]2	−1,[illegible]	−10,869			[illegible]
[illegible]	11	−15,089	[illegible]			[illegible]	
[illegible]	21	−18,165			[illegible]		[illegible]
[illegible]	1					[illegible]	
[illegible]	1[illegible]	−25,367		[illegible]			
[illegible]	20						
[illegible]	[illegible]	[illegible]			[illegible]		

1937

[illegible]	[illegible]	+0.[illegible]	[illegible]		
"	[illegible]	+0.[illegible]		+0.[illegible]	[illegible]
A[illegible]	2	+0.[illegible]	[illegible]	−[illegible]	
	12	+0.[illegible]	[illegible]	[illegible]	
	22	+0.00[illegible]	[illegible]		[illegible]
[illegible]	2	+[illegible]	[illegible]		
"	12	+[illegible]	[illegible]	[illegible]	
"	22	[illegible]		+[illegible]	
Jan.	1	−0.[illegible]6	[illegible]		[illegible]
"	11	[illegible]07	[illegible]	−0.[illegible]8	
"	21	−0.[illegible]	[illegible]		
"	1	0.009		+[illegible]	
Feb.	10	0.01[illegible]	[illegible]		[illegible]
"	20	0.00[illegible]	[illegible]	[illegible]	
[illegible]	1	0.007			[illegible]
"	11	0.00[illegible]	[illegible]	+[illegible]	
	21	−0.002	[illegible]		[illegible]
"	31	+0.002	[illegible]	[illegible]	
Apr.	10	+0.[illegible]	[illegible]		[illegible]
"	20	+0.011	[illegible]	+0.009	
"	30	+0.[illegible]	[illegible]		

[illegible]

[illegible]	[illegible]	+7,[illegible]			[illegible]		[illegible]
	[illegible]	+6,[illegible]				[illegible]	
[illegible]	[illegible]	+5,137	[illegible]	-4,[illegible]			[illegible]
	[illegible]	+[illegible]	[illegible]			[illegible]	
	[illegible]	+2,809	[illegible]		-1[illegible]		[illegible]
[illegible]	[illegible]	+1[illegible]	[illegible]			[illegible]	
	[illegible]	+0,002	[illegible]	-[illegible]			[illegible]
	[illegible]	[illegible]	[illegible]			[illegible]	
[illegible]	[illegible]	-[illegible]	[illegible]		[illegible]		[illegible]
[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	
[illegible]	[illegible]	-647	[illegible]	6,[illegible]		[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]		+[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]14	[illegible]			[illegible]	
	[illegible]	-10,6[illegible]	[illegible]	6,717			[illegible]
[illegible]	[illegible]	[illegible]315	[illegible]			[illegible]	[illegible]
	[illegible]	-1[illegible]	[illegible]		[illegible]		
	[illegible]	-16,731	[illegible]			[illegible]	[illegible]
	[illegible]						
[illegible]	[illegible]	-1[illegible]		-6,[illegible]			

Perturbations in R.A. and Decl.

[illegible]

Perturbations in $\Delta\pi$, $\Delta\delta$, etc., etc. as computed in the differential equations already found in the preceding section, these quantities [illegible], just been interpolated for the respective date [illegible] where the differential equations are found, we find the following values for the variations produced in the co-ordinates α and δ.

	$\Delta\alpha$	$\Delta\omega$	Δi	Δq	ΔM_0	$\Delta\mu$	
Cet. 12.5	− [illegible]	+ 3".517	− 0".156	− 5".714	+ 12".296	+ 0".037	[illegible]
	[illegible]	[illegible]	9.76910$_n$	0.47955	0.37813	[illegible]	
	[illegible]	[illegible]	9.19312$_n$	[illegible]	[illegible]	8.56820	
	9.86004	[illegible]	0.18871	[illegible]	9.95299	1.78690$_n$	
	0.64070$_n$	[illegible]	8.96222	1.23650$_n$	1.46789	0.84420$_n$	
	[illegible]	[illegible]	9.38183$_n$	[illegible]	1.04285	0.35510$_n$	−
$\Delta\alpha$	− 4.372	− 0.067	+ 0.091	− 17.27[illegible]	+ 29.370	− [illegible]	= + [illegible]
$\Delta\delta$	− 1.665	+ 0.160	− 0.241	− 6.[illegible]74	+ 11.033	− [illegible]	= + 0.147
Cet. 16.5	− 1".[illegible]81	+ 3".204	− 0".148	− [illegible]	+ 11".301	+ 0".074	[illegible]
	[illegible]	8.29622$_n$	[illegible]	[illegible]	0.37510	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	1.05312	[illegible]	
	[illegible]	8.67062	9.17793	[illegible]	9.95575	[illegible]	
	[illegible]	8.80191$_n$	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
$\Delta\alpha$	− [illegible]	− 0".063	+ 0.085	− [illegible]	+ [illegible]	− [illegible]	= 0".644
$\Delta\delta$	− [illegible]	+ [illegible]	− 0.223	− 6.439	+ 10.206	− [illegible]	= 0.1[illegible]
Cet. [illegible]	− 1".591	+ [illegible]	− 0".129	− 4".948	+ 10".213	+ 0".031	[illegible]
	[illegible]	[illegible]	[illegible]	0.47375	[illegible]	[illegible]	
	0.19167$_n$	[illegible]	9.14301$_n$	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	0.08094	[illegible]	[illegible]	
	[illegible]	[illegible]	8.89532	1.16818$_n$	1.37880	[illegible]	
	[illegible]	[illegible]	9.30807$_n$	[illegible]	[illegible]	0.29532$_n$	
	− [illegible]	− [illegible]	+ 0.079	− [illegible]	+ [illegible]	− 5.797	= + [illegible]
	− [illegible]	+ [illegible]	− 0.203	− [illegible]	[illegible]	− [illegible]	= + [illegible]

	$\Delta\pi$	$\Delta\Omega$	Δi	Δq	ΔM_0	$\Delta\mu$	
Nov 15.	[illegible]	+2".034	−0.110	−3'.835	+7'.200	+0'.081	[illegible]
	[illegible]	[illegible]	9.70974	0.45130	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	0.85733	[illegible]	
	[illegible]	8.70001	0.11494	[illegible]	9.93741	[illegible]	
	[illegible]	[illegible]	[illegible]	1.03507n	1.19762	[illegible]	
	[illegible]	[illegible]	[illegible]	0.64701n	0.79474	[illegible]	
$\Delta\alpha$	= −1.251	[illegible]	+0.056	−10.841	+15.762	−3.689	= −0.007
$\Delta\delta$	= −0.195	+0.102	[illegible]	−4.436	[illegible]	−1.334	= +0.224
[illegible]	−0".128	[illegible]	[illegible]	[illegible]	+4".022	+0.012	δL = +3'.37[illegible]
	0.18684	8.33085	[illegible]	0.40685	0.27987	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	0.60444	[illegible]	
	9.79073	8.70001	[illegible]	[illegible]	9.88185	[illegible]	
	9.29405n	[illegible]	8.50[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
$\Delta\alpha$	[illegible]	−0".023	[illegible]	[illegible]	+7.661	[illegible]	[illegible]
$\Delta\delta$	[illegible]	+0.054	[illegible]	[illegible]	+3.064	[illegible]	[illegible]
[illegible]	+0.016	+0.101	[illegible]	[illegible]	+0".771	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	9.85157	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	9.78725	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	0.04434	[illegible]	
	[illegible]	[illegible]	0.03735	[illegible]	9.63912	[illegible]	
$\Delta\alpha$	[illegible]	−0.002	−0.043	[illegible]	+1.107	[illegible]	[illegible]
$\Delta\delta$	[illegible]	[illegible]	[illegible]	[illegible]	+0.436	[illegible]	[illegible]

	$\Delta\pi$	$\Delta\beta$	Δi	$\Delta\eta$	$\Delta\beta_1$	$\Delta\mu$	
[illegible]	[illegible]	$-1''.154$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	9.98754	8.20825$_n$	9.17406$_n$	[illegible]	[illegible]	[illegible]	
	0.37199$_n$	0.06221$_n$	9.96379	[illegible]	[illegible]	[illegible]	
	9.54059	8.61972	9.61157	[illegible]	[illegible]	[illegible]	
	0.35983$_n$	8.27046	8.13785$_n$	[illegible]	[illegible]	[illegible]	
	9.91258$_n$	8.68193$_n$	8.87536	[illegible]	[illegible]	[illegible]	
[illegible] =	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
$\Delta\delta$ =	[illegible]	-0.043	$+0.038$	[illegible]	[illegible]	[illegible]	[illegible]
Web.3.5	$-6''.015$	$-1''.751$	$+0''.167$	[illegible]	[illegible]	[illegible]	[illegible]
	9.93612	8.12707$_n$	8.89931$_n$	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	9.44150	8.58263	9.38138	[illegible]	[illegible]	[illegible]	
	0.71526$_n$	8.37636	8.12263$_n$	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
$\Delta\alpha$ =	-5.192	$+0.023$	-0.013	[illegible]	[illegible]	[illegible]	[illegible]
$\Delta\delta$ =	-1.662	-0.067	$+0.040$	[illegible]	[illegible]	[illegible]	[illegible]

	$\Delta\pi$	$\Delta\delta$	$\Delta\iota$	Δs	$\Delta \beta_0$	Δa	
Feb. 9.5	$-9''.197$	$-1''.377$	$+0''.155$	$+4'.225$	$-2''.915$	-0.001	$L = -9''.0$
	9.92558	8.104[illegible]$_n$	8.81140$_n$	0.[illegible]	9.9[illegible]06	1.14[illegible]$_n$	
	0.85715$_n$	0.[illegible]46$_n$	9.[illegible]916	0.65[illegible]	0.16464$_n$	[illegible]$_n$	
	9.41516	8.[illegible]	9.30[illegible]	[illegible]	9.4601	[illegible]$_n$	
	0.76[illegible]3$_n$	[illegible]68	8.08556$_n$	0.14[illegible]0	0.462[illegible]0$_n$	8.89049$_n$	
	0.[illegible]$_n$	[illegible]$_n$	8.58211	0.40415	9.8201	8.66887$_n$	
$\Delta\alpha$ =	$-5''.92$	$+0.024$	-0.012	$+[illegible]$	-2.723	$+0.070$	[illegible]
$\Delta\delta$ =	-1.830	[illegible]	$+0.038$	$+2.526$	-0.677	$+0.047$	[illegible]
Mar. 0.5	$-4''.002$	$-2''.117$	$+0'.282$	$+7''.118$	$+1''.5[illegible]$	$-0''.005$	$L = -2.[illegible]$
	[illegible]66	7.66[illegible]$_n$	8.1[illegible]$_n$	0.19742	9.90[illegible]	1.21162	
	1.164[illegible]$_n$	[illegible]$_n$	9.451[illegible]	[illegible]26	0.18441	9.6989[illegible]$_n$	
	[illegible]241	[illegible]64	[illegible]	[illegible]	9.200[illegible]6	[illegible]	
	0.0324[illegible]$_n$	[illegible]3	[illegible]680	1.04[illegible]	0.09428	8.91060	
	[illegible]	[illegible]$_n$	[illegible]61	[illegible]64	9.4846	8.02648	
$\Delta\alpha$ =	-11.284	[illegible]	[illegible]	$+11.[illegible]14$	$+1.248$	-0.081	[illegible]
$\Delta\delta$ =	2.544	[illegible]	$+0.015$	[illegible]	$+0.200$	-0.011	[illegible]

										w	Residuals
+ [illegible]	− [illegible]	− [illegible]	− 0.062	− 0.59u	+ 1.07w	=	+ [illegible]	− [illegible]	= − [illegible]	[illegible]	+ [illegible]
+ [illegible]	− [illegible]	− [illegible]	− 0.16	− 0.58	+ 0.96	=	+ [illegible]	− [illegible]	= + [illegible]	[illegible]	− 0.66
+ [illegible]	− [illegible]	− [illegible]	− 0.24	− 0.57	+ 0.83	=	+ [illegible]	− [illegible]	= + [illegible]	[illegible]	+ [illegible]
+ [illegible]	− [illegible]	− 1.06	− 0.32	− 0.51	+ 0.46	=	+ [illegible]	+ [illegible]	= + [illegible]	6	− [illegible]
+ [illegible]				− 0.42		=	+ [illegible]	− [illegible]	= + [illegible]		− [illegible]
+ 1.54	+ 1.40x	+ 1.73y	+ 1.24z	− [illegible]	− 0.44w	=	+ [illegible]	+ [illegible]	= + [illegible]	[illegible]	+ 1.00
+ [illegible]	+ [illegible]	+ [illegible]	+ 3.84	− 0.15	− 0.86	=	+ [illegible]	+ [illegible]	= + [illegible]	4	− [illegible]
+ [illegible]	+ [illegible]	+ [illegible]	+ 5.55	− 0.08	− 0.94	=	− [illegible]	+ [illegible]	= + 0.07	[illegible]	+ [illegible]
+ [illegible]	+ 4.46	+ [illegible]	+ 3.98	− 0.06	− 0.94	=	+ [illegible]	+ 0.22	= + 1.16	[illegible]	− [illegible]
+ [illegible]	+ [illegible]	+ 11.69	+ 8.03	− 0.01	− 0.86	=	− 0.15	− 1.11	= − 1.26	1	+ [illegible]
+ [illegible]	− [illegible]	+ [illegible]	+ 1.95z	+ 1.54u	− 3.30w	=	+ [illegible]	− 0.15	= − [illegible]	10	− [illegible]
+ [illegible]	− [illegible]	+ [illegible]	+ 0.85	+ 1.51	− 2.97	=	+ 1.20	− 0.12	= + 1.08	[illegible]	− [illegible]
+ [illegible]	− 0.04	+ 0.06	+ [illegible]	+ 1.46	− 2.6[illegible]	=	+ [illegible]	− [illegible]	= + [illegible]	[illegible]	+ [illegible]
+ [illegible]	− [illegible]	+ 0.12	+ [illegible]	+ 1.30	− 1.61	=	+ 1.27	− 0.22	= + 1.05	[illegible]	− 0.16
+ [illegible]	+ [illegible]	+ 0.27	+ 0.28	+ 1.06	− 0.37	=	+ 0.23	+ 0.01	= + 0.24	[illegible]	+ [illegible]
+ 0.61	+ 0.57x	+ 0.67y	+ 0.47z	+ [illegible]	+ [illegible]	=	+ 0.26	− 0.10	= + 0.16	5	+ [illegible]
+ [illegible]	+ 1.17	+ 1.69	+ 1.16	+ 0.41	+ 2.09	=	+ [illegible]	+ [illegible]	= + 1.14	[illegible]	− [illegible]
+ [illegible]	+ [illegible]	+ [illegible]	+ 1.56	+ 0.24	+ 2.60	=	+ 1.70	+ [illegible]	= − 1.98	[illegible]	− [illegible]
+ [illegible]	+ [illegible]	+ 2.40	+ 1.64	+ 0.20	+ 2.71	=	− [illegible]	+ 0.04	= ± 1.19	[illegible]	+ [illegible]
+ 0.20	+ 1.17	+ 2.65	+ 1.79	+ 0.05	+ 3.15	=	− 2.60	− [illegible]	= − [illegible]	1	+ [illegible]
											Σ = [illegible]

+ 2.39	− 1.13	− [illegible]	− [illegible]	[illegible]	+ [illegible]	+ [illegible]	0.86	[illegible]
+21.51	− 16.47	[illegible]	− [illegible]	[illegible]	+ [illegible]	+ [illegible]	7.74	
+ 2.37	− [illegible]	− [illegible]	[illegible]	[illegible]	+ [illegible]	− [illegible]	− [illegible]	7
+16.59	− [illegible]	− [illegible]	− 4.1[illegible]	− [illegible]	+ [illegible]	− [illegible]	− 16.24	
+ 2.24	− 1.61	− 16.7	− 0.24	− [illegible]	+ [illegible]	[illegible]	[illegible]	6
+14.04	− 9.66	− [illegible]	− [illegible]	− .42	+ [illegible]	− [illegible]	9.42	
+ 2.11	− 1.01	− 1.01	− [illegible]	− [illegible]	+ [illegible]	− [illegible]	[illegible]	6
+ [illegible]	− [illegible]	− [illegible]	− [illegible]	− [illegible]	+ [illegible]	[illegible]	24.12	
+ [illegible]	[illegible]	[illegible]	[illegible]	− 0.42	[illegible]	[illegible]	0.37	[illegible]
+ 7.70				− 1.26		− [illegible]	1.11	
+ [illegible]	+ 1.01	+ 1.7	+ 1.24	− 0.31	− [illegible]	− [illegible]	+ 3.36	[illegible]
+ 7.70	+ [illegible]	+ [illegible]	+ [illegible]	− [illegible]	− [illegible]	[illegible]	+ [illegible]	
+ 1.14	+ [illegible]	+ [illegible]	+ [illegible]	[illegible]	[illegible]	[illegible]	+ 7.61	[illegible]
+ 4.56	+ [illegible]	+ 21.60	+ [illegible]	− [illegible]	− .44	[illegible]	+ [illegible]	
+ 0.97	+ [illegible]	+ [illegible]	+ [illegible]	− [illegible]	− [illegible]	[illegible]	[illegible]	2
+ 1.14	+ [illegible]	+ [illegible]	+ 11.10	− [illegible]	− [illegible]	− [illegible]	[illegible]	
+ [illegible]	+ [illegible]	+ [illegible]	+ [illegible]	− [illegible]	− [illegible]	− 1.16	17.73	3
+ 2.82	+ [illegible]	+ [illegible]	+ 17.94	− [illegible]	− [illegible]	− [illegible]	+ 53.34	
+ 0.81	+ [illegible]	+ 11.6[illegible]	+ [illegible]	− [illegible]	− [illegible]	+ [illegible]	+ 25.77	
+ 0.81	+ [illegible]	+ 11.6[illegible]	+ [illegible]	− [illegible]	[illegible]	+ [illegible]	[illegible]	

l a	k b	N c	z d	u e	w f	−u	s	Versuch
+ 0.90	+ 0.01	+ 0.01	+ 0.95	+ 1.54	− 3.30	− 0.84	− 0.73	10
+ 9.90	+ 0.10	+ 0.10	+ 9.50	+ 15.40	− 33.00	− 8.40	− 7.30	
+ 0.90	+ 0.02	+ 0.04	+ 0.85	+ 1.51	− 2.97	− 1.08	− 0.73	9
+ 8.10	+ 0.18	+ 0.36	+ 7.65	+ 13.59	− 26.73	− 9.72	− 6.57	
+ 0.90	+ 0.04	+ 0.06	+ 0.74	+ 1.46	− 2.63	− 0.81	− 0.24	8
+ 7.20	+ 0.32	+ 0.48	+ 5.92	+ 11.68	− 21.04	− 6.48	− 1.72	
+ 0.87	+ 0.03	+ 0.12	+ 0.47	+ 1.30	− 1.60	− 1.05	+ 0.13	7
+ 6.09	+ 0.21	+ 0.84	+ 3.29	+ 9.10	− 11.27	− 7.35	+ 0.91	
+ 0.76	+ 0.17	+ 0.27	+ 0.28	+ 1.06	− 0.37	− 0.24	+ 1.23	4
+ 3.04	+ 0.68	+ 1.08	+ 1.12	+ 4.24	− 1.48	− 0.96	+ 2.72	
+ 0.61	+ 0.57	+ 0.67	+ 0.47	+ 0.78	+ 6.81	− 0.16	+ 3.75	5
+ 3.05	+ 2.85	+ 3.35	+ 2.35	+ 3.90	+ 4.05	− 0.80	+ 18.75	
+ 0.42	+ 1.17	+ 1.49	+ 1.16	+ 0.41	+ 2.09	− 1.14	+ 5.80	4
+ 1.68	+ 4.68	+ 5.76	+ 4.64	+ 1.64	+ 8.36	− 4.56	+ 23.20	
+ 0.31	+ 1.[illegible]3	+ 2.[illegible]	+ 1.56	+ 0.7[illegible]	+ [illegible]	[illegible]	[illegible]	2
+ 0.61	+ 2.66	+ 4.56	+ 3.12	+ 0.48	+ 0.[illegible]	− 3.96	+ [illegible]	
+ 0.29	+ 1.33	+ 2.40	+ 1.64	+ 0.20	+ 2.71	+ 1.19	+ 7.76	3
+ 0.87	+ 3.99	+ 7.20	+ 4.92	+ 0.60	+ 8.13	+ 3.57	+ 23.28	
+ 0.20	+ 1.17	+ 2.65	+ 1.74	+ 0.05	+ 3.15	+ 2.83	+ 11.84	1
+ 0.20	+ 1.17	+ 2.65	+ 1.74	+ 0.05	+ 3.15	+ 2.83	+ 11.84	

waa	wab	wac	wad	wae	waf	wau	was
+ 51.409	− 39.364	− 43.880	− 1.291	− 12.691	+ 23.016	+ 4.302	− 18.499
+ 29.218	− 28.701	− 30.641	− 2.634	− 9.622	+ 15.926	− 22.065	− 38.480
+ 32.855	− 22.605	− 23.447	− 3.370	− 8.003	+ 11.653	− 9.126	− 22.043
+ 28.276	− 13.028	− 13.028	− 4.205	− 6.761	+ 0.657	− 43.493	− 52.822
+ 10.944	0.000	0.000	0.000	− 2.406	0.000	− 10.658	− 2.120
+ 11.858	+ 11.242	+ 13.321	+ 9.548	− 2.387	− 3.388	− 14.322	+ 25.872
+ 5.108	+ 15.914	+ 24.624	+ 17.510	− 0.684	− 3.921	− 14.820	+ 43.821
+ 1.882	+ 8.361	+ 15.345	+ 10.767	− 0.155	− 1.823	− 0.136	+ 34.241
+ 2.651	+ 12.277	+ 24.139	+ 16.864	− 0.169	− 2.651	− 3.271	+ 50.140
+ 0.656	+ 3.045	+ 9.469	+ 6.504	− 0.008	− 0.607	+ 1.020	+ 20.888
+ 8.100	+ 0.090	+ 0.090	+ 8.550	− 13.860	− 29.700	− 7.560	− 6.870
+ 7.290	+ 0.162	+ 0.324	+ 6.885	− 12.231	− 24.057	− 8.748	− 5.913
+ 6.480	+ 0.288	+ 0.432	+ 5.328	− 10.512	− 18.936	− 5.832	− 1.728
+ 5.249	+ 0.183	+ 0.731	+ 2.862	− 7.017	− 9.505	− 6.294	+ 0.792
+ 2.310	+ 0.517	+ 0.821	+ 0.851	+ 3.223	− 1.125	− 0.730	+ 5.567
+ 1.360	+ 1.738	+ 2.044	+ 1.434	+ 2.379	+ 2.470	− 0.488	+ 11.437
+ 0.766	+ 1.465	+ 2.830	+ 1.949	+ 0.680	+ 3.511	− 1.015	+ 9.744
+ 0.102	+ 0.825	+ 1.414	+ 0.967	+ 0.149	+ 0.161	− 1.228	+ 2.480
+ 0.252	+ 1.157	+ 2.088	+ 1.427	+ 0.174	+ 2.358	+ 1.035	+ 8.491
+ 0.040	+ 0.234	+ 0.530	+ 0.358	+ 0.010	+ 0.630	+ 0.566	+ 2.368
+ 218.075	− 45.400	− 13.735	+ 50.284	+ 8.318	− 35.721	− 143.863	+ 67.955
[aa]	[ab]	[ac]	[ad]	[ae]	[af]	[au]	[as]

[ss] + 67.055

wbb	wbc	wbd	wbe	wbf	wbn	wbs
+ 30.140	+ 33.599	+ 0.688	+ 9.717	− 17.623	− 3.294	+ 14.164
+ 20.950	+ 22.405	+ 1.937	+ 7.024	− 11.626	+ 16.106	+ 28.045
+ 15.553	+ 16.132	+ 2.319	+ 5.506	− 8.018	+ 6.279	+ 15.166
+ 6.742	+ 6.742	+ 2.035	+ 3.243	− 0.318	+ 21.051	+ 28.567
+ 0.000	+ 0.000	+ 0.000	0.000	0.000	− 0.000	0.000
+ 10.658	+ 12.629	+ 9.052	− 2.263	− 3.212	− 13.578	+ 24.528
+ 48.720	+ 55.384	+ 53.606	− 2.004	− 12.005	− 45.370	+ 154.155
+ 37.12[illegible]	+ 68.184	+ 47.841	− 0.689	− 8.103	− 0.603	+ 152.143
− 5.675	+ 114.533	+ 80.012	− 0.803	− 12.577	− 15.521	+ 237.896
− 23.717	+ 56.030	+ 29.106	− 6.049	− 4.188	+ 6.136	+ 125.597
+ 0.001	+ 0.001	+ 0.035	+ 0.154	− 0.330	− 0.084	− 0.073
− 0.004	+ 0.007	+ 0.153	+ 0.272	− 0.535	− 0.194	− 0.131
− 0.012	+ 0.019	+ 0.237	+ 0.467	− 0.842	− 0.259	− 0.077
− 0.006	+ 0.025	+ 0.099	+ 0.273	− 0.338	− 0.221	+ 0.027
− 0.116	+ 0.183	+ 0.196	+ 0.721	− 0.252	− 0.163	+ 1.312
− 1.625	+ 1.909	+ 1.339	+ 2.223	+ 2.309	− 0.456	+ 10.687
− 2.476	+ 7.909	+ 5.424	+ 1.013	+ 9.781	− 2.335	+ 27.144
− 3.535	+ 5.065	+ 4.149	+ 0.638	+ 0.692	− 5.267	+ 10.640
+ 2.307	+ 9.576	+ 6.543	+ 0.799	+ 10.813	− 4.748	+ 38.942
+ 1.269	+ 3.101	+ 2.004	+ 0.058	+ 3.686	+ 2.311	+ 13.853
[illegible]	435.[illegible]	[illegible]	271.115	− 52.686	[illegible]	[illegible]
[illegible]	[bc]	[bd]	[be]	[bf]	−[bn]	bs

wcc	wcd	wcc	wcf	wcn	wcs
+ 37.454	+ 1.102	+ 10.832	− 119.645	− 3.672	+ 15.790
+ 23.957	+ 2.072	+ 7.511	− 12.482	+ 17.223	+ 30.045
+ 16.733	+ 2.405	+ 5.712	− 5.317	+ 6.513	+ 15.731
+ 6.741	+ 2.035	+ 3.243	− 0.318	+ 21.052	+ 28.567
+ 0.000	+ 0.000	0.000	− 0.000	− 0.000	0.000
+ 14.964	+ 10.726	− 6.681	− 3.806	− 16.059	− 24.064
+ 116.640	+ 82.944	− 3.240	− 18.576	− 70.200	+ 207.576
+ 125.136	+ 87.801	− 1.265	− 14.871	− 1.107	+ 279.223
+ 219.821	+ 153.566	− 1.541	− 24.139	− 29.789	+ 456.590
+ 136.656	+ 93.871	− 0.117	− 10.053	+ 14.729	− 261.488
+ 0.001	+ 0.095	+ 0.154	− 0.330	− 0.084	− 0.073
+ 0.014	+ 0.306	+ 0.544	− 1.069	− 0.359	− 0.263
+ 0.029	+ 0.355	+ 0.701	− 1.262	− 0.389	− 0.115
+ 0.101	+ 0.345	+ 1.092	− 1.553	− 0.882	− 0.169
+ 0.292	+ 0.302	+ 1.145	− 0.400	− 0.259	+ 2.084
+ 2.245	+ 1.574	+ 2.613	+ 2.714	− 0.536	+ 12.563
+ 11.424	+ 7.842	+ 2.772	+ 14.125	− 7.706	+ 39.205
+ 10.397	+ 7.113	+ 1.094	+ 1.186	− 9.029	+ 15.240
+ 17.280	+ 11.808	+ 1.440	+ 19.512	− 8.568	+ 70.272
+ 7.023	+ 4.743	+ 0.132	+ 8.348	+ 7.494	+ 31.376
+ 746.908	+ 471.055	+ 30.141	− 70.683	+ 64.547	+1534.472
[cc]	[cd]	[ce]	[cf]	[cn]	[cs]

wdl	wde	wdj	- wdn	wds
+ [illegible]	+ 0.319	- 0.578	- 0.108	+ 0.464
+ 0.179	+ 0.649	- 1.075	+ 1.490	+ 2.593
+ 0.345	+ 0.821	- 1.195	+ 0.936	+ 2.261
+ 0.615	+ 0.979	- 0.096	+ 6.355	+ 7.715
+ 0.000	0.000	- 0.000	0.000	0.000
+ 7.688	- 1.922	- 2.728	- 11.532	+ 20.832
+ 58.982	- 2.304	- 13.209	- 49.920	+ 147.609
+ [illegible]	- 0.888	- 10.434	- [illegible]	+ [illegible]
+ [illegible]	- 1.076	- 16.864	- 20.810	+ 318.973
+ 64.481	- 0.080	- 6.906	+ 10.115	+ 207.094
+ [illegible]	+ 14.630	- 31.350	- 7.980	- 6.935
+ [illegible]	- 11.552	- 22.721	- 8.262	- 5.585
+ [illegible]	+ 8.643	- 15.570	- 4.795	- 1.421
+ [illegible]	+ 4.277	- 5.297	- 3.454	+ 0.428
+ [illegible]	+ 1.187	- 0.414	- 0.269	+ 2.161
+ [illegible]	+ [illegible]	- [illegible]	- 0.276	+ [illegible]
+ [illegible]	+ 1.902	+ 9.695	- 5.290	+ 26.912
+ [illegible]	+ 0.749	+ 0.812	+ 6.1[illegible]	+ 12.480
+ [illegible]	+ 0.454	- 13.333	+ 5.855	+ 48.019
+ [illegible]	+ 0.089	+ 5.639	- 5.066	+ 21.193
+ [illegible]	+ 42.344	- 47.052	- 89.930	+1009.528
[illegible]	[de]	[dj]	-[dn]	[ds]
			[illegible]	+ [illegible]

wee	wef	wen	wes
+ [illegible]	− [illegible]	− 1.062	+ [illegible]
+ 2.355	− 3.893	− 5.400	+ 9.419
− 1.449	− [illegible]	+ 2.223	+ [illegible]
+ 1.561	− 0.153	+ 10.129	+ 12.301
+ 0.529	+ 0.000	+ 2.343	+ 0.466
− 0.480	+ 0.682	+ 2.883	− 5.208
+ 0.090	+ 0.516	+ 1.950	− 5.766
+ 0.012	+ 0.150	+ 0.011	− 2.824
+ 0.011	+ 0.169	+ 0.209	− 3.200
+ 0.000	− 0.009	+ 0.013	− 0.258
+ 23.916	− 50.820	− 12.936	− 11.242
+ 20.521	− 40.363	− 14.677	− 9.920
+ 17.053	− 30.718	− 9.461	− 2.803
+ 11.830	− 14.651	− 9.555	+ 1.183
+ 4.494	− 1.569	− 1.018	+ 8.183
+ 3.042	+ 3.159	− 0.624	+ 14.628
+ 0.672	+ 3.428	− 1.870	+ 9.512
+ 0.115	+ 0.125	− 0.950	+ 1.920
+ 0.120	+ 1.626	+ 0.714	+ 5.856
+ 0.003	+ 0.158	+ 0.142	+ 0.592
+ 91.686	− 140.671	− 26.162	+ 32.771
[ec]	[ef]	− [en]	[es]
		Check	+ 32.771

[ff]	-wfn	wfs	wnn	-wns
+ 10.304	+ 1.926	- 8.282	+ 0.360	- 1.548
+ 6.451	- 8.937	- 15.591	+ 12.382	+ 21.549
+ 4.134	- 3.237	- 7.391	+ [illegible]	- 6.123
+ 0.015	- 0.993	- 1.206	+ 65.736	+ 79.837
+ 0.000	0.000	0.000	+ 10.379	- 2.064
+ 0.968	- 4.092	- 7.392	+ 17.298	- 31.248
+ 2.958	+ 11.180	- 33.057	+ 42.250	-124.930
+ 1.767	+ 0.132	- 33.182	+ 0.004	- 2.471
+ 2.691	+ 3.271	- 50.140	+ 4.037	- 61.574
+ 0.739	- 1.083	- 22.179	+ 1.585	+ 32.495
+108.900	+ 27.720	+ 24.090	+ 7.056	+ 6.132
+ 79.355	- 28.869	+ 19.512	+ 10.497	+ 7.096
+ 58.335	- 17.042	+ 5.649	+ 5.249	+ 1.555
- 18.145	- 11.834	- 1.465	+ 7.717	- 0.955
+ 0.545	- 0.355	- 2.857	+ 0.231	- 1.853
+ 3.280	- 0.648	+ 15.187	+ 6.128	- 3.000
+ 17.472	- 9.530	+ 48.485	+ 5.193	- 26.443
+ 0.135	- 1.029	+ 2.080	+ 7.540	- 15.540
+ 22.032	+ 9.675	+ 79.349	+ 4.248	+ 34.843
+ [illegible]	- [illegible]	+ [illegible]	+ 8.009	- 33.507
+348.144	+ 40.551	+ 47.882	+212.747	-- 44.918
+ [ff]	-[fn]	[fs]	[nn]	- [ns]
	[illegible]	- [illegible]	Check	- 44.918

[an] = + 143.863	[aa] = + 218.075								
[bn] = + 32.714	[ab] = − 45.400	[bb] = + 270.762							
[cn] = + 64.547	[ac] = − 13.735	[bc] = + 435.333	[cc] = + 746.908						
[dn] = + 80.930	[ad] = + 80.284	[bd] = + 257.224	[cd] = + 471.055	[dd] = + 345.603					
[en] = + 26.162	[ae] = + 8.318	[be] = + 27.115	[ce] = + 30.141	[de] = + 42.344	[ee] = + 91.686				
[fn] = − 99.551	[af] = − 35.721	[bf] = − 52.686	[cf] = − 70.683	[df] = − 97.052	[ef] = − 140.671	[ff] = + 345.144			
[gn] = + 44.918	[ag] = + 67.958	[bg] = + 559.634	[cg] = + 1,534.472	[dg] = + 1,009.528	[eg] = + 32.771	[fg] = + 47.382			
[hn] = + [illegible]									

Normal Equations.

(a) $+218.075t - 45.400x - 13.735y + 80.284z + 8.318u - 35.721w = +143.863$

(b) $-45.400t + 270.762x + 435.333y + 257.224z + 27.115u - 52.686w = +32.714$

(c) $-13.735t + 435.333x + 746.908y + 471.055z + 30.141u - 70.683w = +64.547$

(d) $+80.284t + 257.224x + 471.055y + 345.603z + 42.344u - 97.052w = +80.930$

(e) $+8.318t + 27.115x + 30.141y + 42.344z + 91.686u - 140.671w = +26.162$

(f) $-35.721t - 52.686x - 70.683y - 97.052z + 140.671u - 345.144w = -99.551$

The following is the solution of these normal equations:—

	[ab]	[ac]	[ad]	[ae]	[af]	[an]	[as]
[illegible]	− 45.400	− 13.735	+ 80.284	+ 8.318	− [illegible]	+143.863	+ 67.958
[illegible]	[illegible]	[illegible]	[illegible]	[0.9200159]	[illegible]	[2.1579491]	[illegible]
	+ 270.7620	+ 435.3330	+ 257.2240	+ 27.1150	− 52.6860	+ 32.7140	+ 559.6340
[illegible]	+ 9.4516	+ 2.8594	− 16.7139	− 1.7317	+ 7.4366	− [illegible]	− 14.1475
	+ 261.3104	+ 432.4736	+ 273.9379	+ 28.8467	− [illegible]	+ 62.6642	+ 573.7515
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[2.4414030]

	[illegible]	[illegible]	[ae]	[illegible]	[illegible]	[as]	Check
	[illegible]	+ [illegible]	+ [illegible]	− [illegible]	+ [illegible]	+ 1534.4720	
[illegible]	[illegible]	− [illegible]	− [illegible]	+ 2.2495	− [illegible]	+ 4.2801	
	+ [illegible]	+ 476.1115	+ [illegible]	− 72.9328	+ [illegible]	+ 1538.7521	+ 1538.7521
[illegible]	+ [illegible]	+ [illegible]	+ 47.7418	− 99.5040	+ [illegible]	+ 1446.1252	
	+ 30.2011	+ 22.7391	− 17.0769	+ 26.5712	− 30.1[illegible]	+ 92.6269	+ 92.6270
	[1.4813150]	[illegible]	[1.2324090]	[illegible]	[illegible]	[1.9667371]	
		+ 345.6030	+ [illegible]	+ 97.0520	+ [illegible]	+ 1009.5250	
[illegible]		+ 29.5564	+ [illegible]	− 13.1566	+ [illegible]	+ [illegible]	
		+ 316.0466	+ 39.2817	− [illegible]	+ 36.9670	+ 984.5093	+ 984.5093
[0.0204955]		− [illegible]	+ [illegible]	− [illegible]	+ [illegible]	+ 916.0063	[illegible]
		− [illegible]	+ 9.0410	− 20.8734	− 28.7254	+ 68.5030	+ 68.5030
[illegible]		+ [illegible]	− 12.8194	+ 19.9466	− [illegible]	+ 69.5337	+
		+ 11.8[illegible]	+ 21.8604	− 40.8200	− 6.1279	− 1.0307	− 1.0307
		[1.0719185]	[illegible]	[illegible]	[illegible]	[illegible]	
			+ 91.6[illegible]	− 140.6710	+ 26.1620	+ 32.7710	
[illegible]			− [illegible]	− 13625	+ 5.4874	+ 2.5921	
			+ 91.3687	− 139.3085	+ 20.6746	+ 30.1789	+ 30.1789
[9.0429395]			+ [illegible]	− 6.6370	+ 6.9176	+ 96.4590	
			− [illegible]	− [illegible]	+ 13.7570	− 66.2801	− 66.2801
[illegible]			− [illegible]	− 14.9798	+ 16.9706	− 52.2193	
			− 78.5570	− [illegible]	− [illegible]	− 14.0608	− 14.0608
[illegible]			− [illegible]	− 75.6158	− 11.3514	− 1.9092	
			− [illegible]	− 42.0760	+ 8.1378	− 12.1515	− 12.1514
			[1.5804962]	[illegible]	[0.9105070]	[illegible]	

	[uc]	[ud]	[ui]	[uf]	[uu]	[us]	Check
			[9.2143178$_n$]	+ 345.1440	− 99.5510	+ 47.8820	
				+ 5.5512	− 23.5649	− 11.1316	
				+ 339.2929	− 75.9861	+ 59.0136	+ 59.0137
			[9.3618810$_n$]	+ 13.8331	− 14.4179	− 201.0407	
				+ 325.4598	− 61.5682	+ 260.0543	+ 260.0543
			[9.9430962]	+ 23.3081	− 26.4057	+ 81.2519	
				+ 302.1517	− 35.1625	+ 178.8024	+ 178.8024
			[0.5[illegible]$_n$]	+ 141.1[illegible]	+ [illegible]	+ [illegible]	
				+ 160.9541	− 56.3591	+ 175.2372	+ 175.2372
			[0.0435382$_n$]	+ 46.5125	− 8.9959	+ 13.4325	
				+ 114.4413	− 47.3636	+ 161.8044	+ 161.8045
				[illegible]	[illegible]	[illegible]	

	[n n]	[ns]	
	+ 212.7470	+ 44.9180	
[9.8193423]	+ 94.4057	+ 44.8316	
	+ 117.8413	+ 0.0864	+ 0.0863
[9.3798625]	+ 15.0275	+ 209.5395	
	+ [illegible]	− [illegible]	+ [illegible]
[9.9972876$_n$]	+ 29.9151	− 92.0502	
	+ 72.8989	− 117.4029	− 117.4029
[illegible]	+ [illegible]	+ [illegible]	
	+ 69.7168	− 117.9381	− 117.9381
[9.3300105]	+ 1.7398	− 2.5981	
	+ 67.9770	− 115.3400	− 115.3402
[9.6168583$_n$]	+ 19.6020	− 66.9651	
	+ 48.3750	− 48.3749	

Making the necessary eliminations we find the following

w	u	z	y	x	t
−0.41386	+0.21381	−0.51928	−0.99377	+0.23981	+0.65969
	−0.45756	−1.43157	+0.36304	−0.09522	−0.06779
		+0.45153	−0.13741	+0.02691	+0.00929
			+1.12552	+1.57177	+0.55197
				−0.59145	+0.01788
					+0.23[illegible]
−0.41386	−0.24375	−1.49932	+0.35737	+1.15181	+1.41[illegible]
[9.616[illegible]]	[9.3869446]	[0.1758[illegible]]	[9.5531181]	[0.061380[illegible]]	[0.1494747]
r ± 0.12	r ± 0.24	r ± 0.55	r ± 0.55	r ± 0.49	r ± 0.20

Computation of the weights of the deduced quantities:

t	x	y	z	u	w
	8.63690	8.89[illegible]	9.14830	[illegible]	[illegible]
		0.43760	8.57740	0.29444	[illegible]
			[illegible]	0.58196	[illegible]
				[illegible]	[illegible]
					[illegible]
+0.0046	+0.0038	+0.0330	+0.0182	[illegible]	
+0.0002	+0.0004	+0.0477	+0.0847	+0.01018	
+0.0026	+0.0032	+0.1003	+0.0901		
+0.0119	+0.0517	+0.0151			
+0.0060	+0.0056				
[illegible]					
+0.0268	+0.1547	+0.1961	+0.1930	[illegible]	[illegible]
p 1.57197	0.81051	0.70752	0.71444	[illegible]	[illegible]
p_x 3.73	p_x 0.65	p_y 0.51	p_z 0.52	[illegible]	[illegible]

[illegible] the ratios of the weight.

	(1)	(2)	[illegible]	(4)	(5)	(6)	(7)
t_d	0.37840	0.37475	0.36922	0.34044	[illegible]	1.18752	[illegible]
x_d	[illegible]	0.23805n	[illegible]	[illegible]	0.00000	0.16435	[illegible]
y_d	0.30963n	0.26717n	0.27272n	0.02531n	[illegible]	[illegible]	[illegible]
z_d	8.77815n	9.20412n	[illegible]	1.56515n	[illegible]	0.07342	[illegible]
u_d	[illegible]	[illegible]	[illegible]	[illegible]	1.62325n	[illegible]	[illegible]
w_d	[illegible]	9.98227	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

	(8)	(9)	[illegible]
t_d	9.98677	9.97313	[illegible]
x_d	0.63448	[illegible]	[illegible]
y_d	0.89818	[illegible]	[illegible]
z_d	0.74429	[illegible]	[illegible]
u_d	8.76309n	[illegible]	[illegible]
w_d	9.97313n	[illegible]	[illegible]

	(11)	(12)	(13)	(14)	(15)	[illegible]	[illegible]
t_0	[illegible]	[illegible]	[illegible]	9.93952	[illegible]	[illegible]	[illegible]
x_0	[illegible]	[illegible]	8.66[illegible]n	8.47712n	9.23049	[illegible]	[illegible]
y_0	[illegible]	[illegible]	8.77[illegible]	9.07918	[illegible]	9.52607	[illegible]
z_0	1.77772	9.92942	[illegible]	[illegible]	9.44716	[illegible]	[illegible]
u_0	0.18752	0.17898	[illegible]	0.11394	0.02531	[illegible]	[illegible]
w_0	0.51851n	0.47276n	0.41796n	0.20623n	[illegible]	[illegible]	[illegible]

	(16)	(17)	[illegible]
t	1.47136	9.46240	[illegible]
x	0.12385	0.12385	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.19312	0.21454	[illegible]
[illegible]	9.38021	9.30103	[illegible]
[illegible]	0.41[illegible]	9.43297	[illegible]

t_α	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
x_α	0.32383$_u$	0.29943$_u$	[illegible]	[illegible]	[illegible]
y_α	9.86275$_u$	9.82079$_u$	[illegible]	9.57843$_u$	[illegible]
z_α	8.95404	9.38001	[illegible]	[illegible]	[illegible]
u_α	9.15779	9.15037	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	9.53594$_u$	[illegible]	

	[illegible]	[illegible]	[illegible]	0.12260	0.05776
	0.22573	0.60471	[illegible]	[illegible]	0.74871
	[illegible]	[illegible]	[illegible]	[illegible]	0.62073
	[illegible]	[illegible]	[illegible]	[illegible]	1.08061$_u$
	8.87930	8.56303	[illegible]	8.16507	[illegible]

t_δ	0.10371	0.10371	[illegible]	0.08977	0.03028
x_δ	8.06138	8.36241	[illegible]	8.53850	9.29187
y_δ	7.55312	8.15518	8.33127	[illegible]	8.78448
z_δ	0.15361$_u$	0.10531$_u$	0.04512$_u$	9.84799$_u$	9.64305$_u$
u_δ	9.57446$_u$	9.56592$_u$	9.55129$_u$	9.50088$_u$	9.41225$_u$
w_δ	0.13537	0.08962	0.03682	9.82369	[illegible]

	9.93480	9.77272	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	0.39073$_u$	[illegible]
	9.27903$_u$	8.99973$_u$	[illegible]	8.68797$_u$	[illegible]
	9.52533$_u$	9.93701$_u$	[illegible]	0.04963$_u$	[illegible]

$-u_\alpha$	+0.20	−1.33	−0.65	[illegible]	[illegible]	−1.86	[illegible]	[illegible]
t_α	+3.37	+3.34	+3.30	[illegible]	+2.70	+2.17	+1.61	+1.37
x_α	−2.11	−1.77	−1.85	−1.22	[illegible]	+1.68	[illegible]	[illegible]
y_α	−0.73	−0.66	−0.60	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	−1.86	−5.76	−8.32
u_α	+0.14	+0.14	+0.14	+0.12	[illegible]	[illegible]	+0.04	+0.02
w_α	[illegible]	−0.40	−0.34	−0.21	[illegible]	[illegible]	+0.36	+0.39
[illegible]	[illegible]	[illegible]	[illegible]	−1.43	[illegible]	[illegible]	[illegible]	+1.42

$-u_a$	[illegible]	[illegible]
t_a	[illegible]	[illegible]
x_a	[illegible]	[illegible]
y_a	[illegible]	[illegible]
z_a	[illegible]	[illegible]
u_a	[illegible]	[illegible]
w_a	[illegible]	[illegible]
v_a	[illegible]	[illegible]

$-u_b$	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
t_b	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
x_b	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
y_b	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
z_b	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
u_b	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
w_b	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
v_b	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

$-u_c$	[illegible]	[illegible]	[illegible]	[illegible]
t_c	[illegible]	[illegible]	[illegible]	[illegible]
x_c	[illegible]	[illegible]	[illegible]	[illegible]
y_c	[illegible]	[illegible]	[illegible]	[illegible]
z_c	[illegible]	[illegible]	[illegible]	[illegible]
u_c	[illegible]	[illegible]	[illegible]	[illegible]
w_c	[illegible]	[illegible]	[illegible]	[illegible]
v_c	[illegible]	[illegible]	[illegible]	[illegible]

Σ [illegible]

$$r = \sqrt{\frac{[vv]}{m-\mu}} \times 0.6745$$

$[vv]$ 1.68457
$m-\mu$ 1.14613
0.53844
0.26922
log q' 9.82898
[illegible]
$r = \pm 0.''012$

$$r_t = \frac{r}{\sqrt{p_t}} \text{ [illegible]}$$

[illegible] substitutions we find

$$\Delta \Omega = 100 w$$
$$\Delta i = u - [illegible] \Delta \Omega$$
$$\Delta \mu = z \times 10$$
$$\Delta \pi = 100 y$$
$$\Delta \varphi = 10 x$$
$$\Delta M_0 = t - [0.12698] \Delta \varphi - [9.90697] \Delta \pi + [1.89651] \Delta \mu .$$

$$\log w = 9.6168583_n$$
$$\text{"} \quad u = 9.3869446_n$$
$$z = 0.17[illegible]_n$$
$$\text{"} \quad y = 9.5521181$$
$$x = 0.0613809$$
$$\text{"} \quad t = 0.1494747$$

$$\Delta i = u - [8.70583] \Delta \Omega$$
$$- [8.70583] \Delta \Omega = [0.322688] = + 2.10227$$
$$u = - 0.24375$$
$$\Delta i = + 1.8585$$

$$\Delta M_0 = t - [0.12698] \Delta \varphi - [9.90697] \Delta \pi + [1.89651] \Delta \mu$$
$$[1.89651] \Delta \mu = - 11.8142$$
$$[9.90697] \Delta \pi = - 28.8462$$
$$[0.12698] \Delta \varphi = - 15.4298$$
$$\Sigma = - 56.0902$$
$$t = + 1.4108$$
$$\Delta M_0 = - 54.6794$$

$$\Delta \Omega = - 41''.386$$
$$\Delta i = + 1.858$$
$$\Delta \mu = - 0.1499$$
$$\Delta \pi = + 35.737$$
$$\Delta \varphi = + 11.518$$
$$\Delta M_0 = - 54.67[illegible]$$

Applying these corrections to the elements together with the [illegible] and the precession to reduce the elements to the epoch of 1889.0 we finally derive the following corrected elements

$T = 1888.0$

π	=	[illegible]	$\Delta\pi$	=	+ [illegible]
i	=	2 21 [illegible]	[illegible]		+ [illegible]
Ω	=	254 [illegible]	[illegible]		− [illegible]
$\Omega + 7\frac{1}{2}°$	=	261 [illegible]	$\Delta\pi'$	=	− [illegible]
$\cos(\Omega + 7\frac{1}{2})$	=	9.14481$_n$			
$\log 0''.49$	=	[illegible]	$\Delta\Omega$	=	− [illegible]
$\sin(\Omega + 7\frac{1}{2}°)$	=	[illegible]	[illegible]	=	+ [illegible]
$\cot i$	=	1.38481	[illegible]	=	[illegible]
$\log \delta'\Omega$	=	[illegible]	$\Delta\Omega$	=	+ [illegible]
$\delta'\Omega$	=	11''.87			
$\Delta\pi$	=	+ 50.24	Δi	=	+ [illegible]
$\Delta\Omega$	=	+ 62.11	[illegible]	=	− [illegible]
Δi	=	− 0.07	[illegible]	=	+ [illegible]
			Δi	=	+ [illegible]

$\log p$	=	0.3321288	$\Delta\omega$	=	+ [illegible]
$\sec^2 q$	=	0.0099048	[illegible]	=	− [illegible]
$\log a$	=	0.3420286	$\Delta\omega'$	=	+ [illegible]
$\log k''$	=	3.5500066			
$\log a^{3/2}$	=	0.5130429	[illegible]	=	[illegible]
$\log u$	=	3.0369637	[illegible]	=	[illegible]
u	=	1088''.87	[illegible]		

Corrected Elements.

1889. February 24.0 Greenwich M.T.

M	=	187° 31' 50''.6	
π	=	[illegible]	mean equinox and Ecliptic 1889.0.
Ω	=	254 [illegible]	
i	=	2 21 [illegible]	
φ	=	[illegible]	
u	=	1088''.87	
[illegible]		[illegible]	

The author of the preceding paper, Charles Augustus Rufus Borst, was born in Middlesex, Schoharie County, State of New York.

His early education was acquired under a tutor. In the year 1872 he entered Clinton Liberal Institute where he remained four years, pursuing both the scientific and classical courses in which courses he was graduated in 1876. After graduation he was appointed Principal of the Union School at Oriskany Falls, N.Y. which appointment he accepted for one year.

He entered [illegible] in 1877 and at [illegible] years was graduated with

[illegible] in the class of 1881

[illegible] years he pursued in addition to the prescribed College Course, graduate work in Mathematics and Astronomy under the Professor in Mathematics and the Director of the Litchfield Observatory, preparatory to the appointment as Assistant Astronomer in the Litchfield Observatory. His position was entered upon July 1, 1881 and held for seven years.

During this time he labored without interruption upon the [illegible] work [illegible] on in the Observatory, especially may be mentioned the labor upon the "Celestial Charts" under construction, 30,000 of the zone stars observed as a basis for twenty charts, were reduced [illegible] to the common epoch of 1860.0. Also he made the reductions of 14,000 "Solar Spot" Observations and put the result in [illegible] for [illegible].

In the year 1886, pending a year's absence of the Director in Europe, [illegible]

to take charge of the Chair of Astronomy in the College, and gave the required instruction in Astronomy.

In 1884 he received the Degree of A. M. from Hamilton College.

As a special work in the science of Astronomy the Author has, during the last seven years, collected from the astronomical literature the published positions of the comparison stars used in various astronomical investigations during the last half century and has reduced them to a common epoch and formed two catalogues containing together 35,000 star positions which work is ready for publication.

In June 1888 he was appointed a Fellow in Astronomy in Johns Hopkins University and in October he entered upon the work of setting and adjusting the astronomical instruments and giving instruction in observing [illegible] of [illegible].

The following year [illegible] was appointed a member of the Academic Staff and has given instruction in Astronomy up to the present time.

In the University he was attended courses of lectures given by Professors Kimball and Craig and under Professor Newcomb was followed in more advanced studies in "Celestial Mechanics."